ENVIRONMENTAL STUDY OF LAKE ANNA

AND THE LOWER NORTH ANNA RIVER

ANNUAL REPORT FOR 1995

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Executive Summary

Following the successful completion of the North Anna Power Station 316(a) Demonstration in 1986, Virginia Power (the Company) agreed to continue selected environmental monitoring studies on Lake Anna and the North Anna River. Correspondent with the recommendations in the three-year review of post-316(a) studies for 1989-1991, the Company requested and was granted a reduction in certain of the monitoring programs by the Department of Environmental Quality (DEQ). The revised annual study program was to be continued with a review every three years for possible revisions or changes. This report represents data from 1995.

Station generation for 1995 was again an outstanding year for efficiency, with generation levels comparable to previous years. Water temperature and fish community data for 1995 both in the lake and downstream were similar to historical data. For example, total numbers of fish collected in lake electrofishing surveys in 1995 were similar to 1994 totals and continue within the range of previous years. The numbers collected from gill netting surveys for 1995 were less than 1994 totals but closely follow historical data. In 1995, Lake Anna anglers reported 102 citation largemouth bass Micropterus salmoides (3.6 kg or greater), ranking Lake Anna as the leader in the state.

The 1995 hydrilla Hydrilla verticillata survey indicated substantial reduction in the acreage in the lake and in the Waste Heat Treatment Factility (WHTF). This reduction is believed to be the result of several factors including abnormal weather conditions which produced record rainfall in the Lake Anna drainage area resulting in less than optimal growing conditions for hydrilla.

In the lower North Anna River, electrofishing surveys conducted in 1995 found numbers and biomass of fish collected similar to those obtained in 1994, but reduced from previous years. These findings are also the result of unusually high water in the spring and early summer of 1995. Density estimates for smallmouth bass and largemouth bass were generally only slightly different from those of recent years.

Overall, the data collected in 1995 reveal that no major changes have occurred in the lake or river ecosystem. The review of the 1995 data indicate that Lake Anna and the North Anna River contain healthy, well-balanced ecological communities.

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1.0 Introduction

In 1972, the North Anna River was impounded to create Lake Anna, a 3885 hectare (9600 acres) reservoir (lake) that provides condenser cooling water for the North Anna Power Station (NAPS). Adjacent to Lake Anna is a 1376 hectare (3400 acre) Waste Heat Treatment Facility (WHTF) that receives the cooling water and transfers excess heat from the water to the atmosphere before discharging into the lower reservoir.

Aquatic monitoring studies have been conducted on Lake Anna since its inception. In January, 1984, the Company initiated an extensive Section 316(a) demonstration study (P.L. 95-500) to determine if proposed effluent limitations on thermal discharges from the power station were more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in Lake Anna and the lower North Anna River. The final report (Virginia Power 316(a) Report 1986) successfully demonstrated that the operation of the power station had not resulted in appreciable harm to the biological community. The then Virginia Water Control Board (VWCB) accepted the study as a successful demonstration in September, 1986.

Subsequent to the 316(a) study, the Company committed with the VWCB to continue environmental monitoring and annual reporting on Lake Anna and the lower North Anna River as part of a post 316(a) agreement. Also, following each three year period of data collection, a summary report is provided with recommendations for future studies. This report presents the findings for calendar year 1995, the first year of the third three-year study plan for Lake Anna.

2.0 Station Operation

North Anna Power Station (NAPS) operated at or above 85% of its total capacity for the first quarter and over 97% for the third and fourth quarter of 1995 (Table 2.0-1). Unit 2 was removed from service during the second quarter of 1995 for steam generator replacement resulting in the 65% capacity for the third quarter. Except for this outage, the station averaged 88% capacity for 1995. (Figure 2.0-1). These data are comparable to the historical records for generation in 1988 and 1990. With the exception of the spring of 1992 when both Units 1 and 2 were out of service, the station has operated at an average greater than 81% of capacity for the period 1992-1995 (Figure 2.0-1) Past studies and reports have shown that these levels of generation have had no adverse impact on the ecology of Lake Anna (Virginia Power, 1988, 1990).

3.0 Lake Anna

3.1 Temperature

Lake water temperature data in 1995 were collected using continuous measurements (fixed temperature recorders) and instantaneous field surveys. Continuous temperatures were measured using Endeco model 1144SSM temperature recorders which measure and record the water temperature at one hour intervals at seven (7) stations in the lake and three (3) stations in the WHTF. These instruments were located one meter below the lake surface at the stations depicted in Figure 3.1-1, the lone exception being Station NALST10. The instrument at this station was located at a depth of three meters. A summary of the data recorded by these instruments for 1995 is presented in Table 3.1-1 as the means of daily high, mean and low temperatures.

The maximum temperature recorded in Table 3.1-1 for the lake in 1995 was 32.1°C recorded in July at Station NAL208T located mid-lake at the State Route 208 bridge. The lowest temperature was 4.2°C recorded in February at Station NAL719NT. These 1995 high and low temperatures are similar to historical records and approximate values for 1994 (maximum of 30.4°C and minimum of 2.2°C).

Quarterly temperature surveys conducted in February, May, August, and November provide instantaneous temperature data which were used to assess seasonal thermal stratification patterns in the lake. Temperatures were measured in one (1) meter intervals, surface to bottom, at the stations shown in Figure 3.1-5. The February survey data indicated no stratification. The May survey results indicate a metalimnion at the 9 to 13 meter depth in the lower lake which disappears in the more shallow, upper portion of the lake. This metalimnion was again evident in the August survey but had migrated to a depth of 16 to 19 meters in the lower lake stations and was again absent in the mid and upper lake stations. The temperatures recorded in the November survey indicate uniform temperatures recorded throughout the lake with approximately 1°C change surface to bottom for each station (Table 3.1-2). These stratification patterns in the lake were not unusual and are similar to previously reported patterns (Virginia Power 1986-1994).

3.2 Fish Population Studies - Gill Net Results

The monitoring of fish assemblage abundance and species composition for Lake Anna and the WHTF continued in 1995 using the same basic sampling technologies applied since 1972. Experimental gill netting was used to capture fishes which normally inhabit the deeper strata of the lake, or exhibit a diel movement to and from the shoreline. Sampling frequency for 1995 was similar to historical sampling with samples collected during February, May, August, and November at the stations shown in Figure 3.2-1. Experimental gill nets were set near littoral drop-off areas with procedures remaining unchanged since 1972. Fish collected by gill netting were returned to the laboratory where all individuals were measured to the nearest millimeter total length and weighed to the nearest 0.1 gram. Surface water temperature (°C), dissolved oxygen (mg/l), pH and conductivity (μmhos) were recorded at the time of each sample collection.

Seventeen (17) species of fish representing seven (7) families were collected in Lake Anna and the WHTF by quarterly gill netting in 1995 (Table 3.2-1). A total of 810 fish weighing 358.1 kg was collected from four stations in the lake and two stations in the WHTF (Table 3.2-2). The numerical total is less than 1994 while the weight is approximately the same as 1994. Of the 810 total fish collected, 559 (245.5 kg) were collected in the lake and 251 (112.7 kg) in the WHTF.

Figure 3.2-2 graphically presents the relative percentages of numbers and weights of species collected by gill netting in 1995 in the lake proper. The numerically dominant species was gizzard shad Dorosoma cepedianum followed by black crappie Pomoxis nigromaculatus and striped bass Morone saxatilis. These are similar to 1994 results when gizzard shad and black crappie were ranked 1 and 2, and are also similar to past results as shown in Figure 3.2-3.

When the 1995 data are compared for weights, the dominant species in the lake was striped bass followed by gizzard shad and channel catfish Ictalurus punctatus. These data are similar to 1994 data with the same species recorded as the top three (Virginia Power 1994).

The numerically dominant species collected by gill netting in the WHTF, as shown in Figure 3.2-4, was gizzard shad, followed by channel catfish and white perch Morone americana. The results are similar to historical trends over the last four years (Figure 3.2-3).

The weight-dominant species in the WHTF for 1995 was channel catfish, followed by gizzard shad and common carp Cyprinus carpio. These data are the same as 1994 and similar to past results which found channel catfish and gizzard shad in first and second places respectively and the common carp in third (Virginia Power, 1993, 1992).

The 1995 catch per unit effort (CPUE) data for gill netting for all stations combined was less than the CPUE for 1994 (Figure 3.2-5). The average number per sample decreased when compared to 1994 while the average weight per sample increased. These figures remained within the historical ranges (Figure 3.2-6).

Table 3.2-3 illustrates the 1995 gill netting data by number and weight for each individual collection in both the lake and WHTF. The average number of fish collected by station ranged from a low of 22 fish recorded at the Lagoon 3 to a high of 53.7 recorded at the North Anna Arm Station. The highest number in 1995 for any single set was 98 (36% gizzard shad) recorded in August at the North Anna Arm Station. The average weight of fish collected during 1995 ranged from a low of 11.6 kg recorded at Lagoon 3 to a high 17.3 kg recorded at the Thurman Island. The greatest weight for any single set in 1995 was 29.1 kg recorded in February at the Lagoon 1 Station (39% channel catfish).

When the 1995 gill net data are examined seasonally, the August collection yielded the greatest number of fish representing 28% of the total catch. In contrast, the February sample ranked first in weight with 111.4 kg (47% M. saxatilis).

3.3 Fish Population Studies - Electrofish Results

Shoreline boat electrofishing was also used in 1995 as a monitoring tool for those fish populations which normally occupy the shoreline habitat. The techniques, stations, and frequency have remained virtually unchanged since 1972. Sampling was performed in 1995 in February, May, August, and November at the stations identified in Figure 3.2-1. Shoreline electrofishing stations are 100 meters in length and normally contain a brush pile, except for the dike stations which are comprised of uniform rip-rap.

All fish collected were returned to the laboratory for enumeration with the exception of larger game fish in good condition which were measured, weighed, and released in the field. In the laboratory, at least twenty-five (25) individuals per species from each electrofishing station were measured to the nearest millimeter total length and weighed to the nearest 0.1 gram. Those individuals over twenty-five (25) per species were enumerated and bulk weighed. Surface water temperature (°C), dissolved oxygen (mg/l), pH and conductivity (μmhos) were recorded at the time of each sample collection.

Twenty-one (21) species of fish representing nine (9) families were collected by electrofishing operations in the lake and WHTF in 1995 (Table 3.2-1). A total of 4,628 fish weighing 112.8 kg was collected from five stations in the lake and four stations in the WHTF during the quarterly sampling periods. Of the 4,628 fish collected during 1995, 2787 (80.0 kg) were collected from the lake and 1841 (32.8 kg) were collected from the WHTF (Table 3.3-1). The dominant species for the lake and WHTF in both weight and number was the bluegill Lepomis macrochirus (Figures 3.3-1 and 3.3-2). Largemouth bass ranked second in weight in both the lake and WHTF while ranking numerically second in the lake and third in the WHTF. These results are a repeat of the 1994 data and similar to the historical records (Virginia Power, 1994). The relative make-up of the species composition for 1995 was similar to 1994 which continues the historical trend for both the lake and WHTF (Figure 3.3-3).

The 1995 electrofish data are summarized by each individual station for number and weight in Table 3.3-2. This table reveals the average number of fish collected ranged from a low of 49.3 recorded at Lagoon 3 Station to a high of 243.5 recorded at Thurman Island. The largest average weight per collection was 7.5 kg recorded at Thurman Island Station. The single highest total weight for 1995 of 22.3 kg (48%bluegill) was recorded in November at Thurman Island Station.

When the data are compared seasonally, the results are similar to previous years with the greatest number of fish being collected by electrofishing in the November (1,870) and February (1,308) collections. The November collection resulted in the largest quarterly weight total of 42.5 kg comprised of bluegill (20.5%) and largemouth bass (11%). Typically in the fall, recruitment of the young-of-the-year (YOY), plus the return of the fish to shallow water as the weather moderates, generally increases the number of fish available to collection by shoreline electrofishing.

The average number of fish collected per electrofishing sample for 1995 was 128.5 which is above the average for 1994, and within the historical range (Figure 3.3-4). The average weight per electrofishing sample for 1995 was 3.1 kg, which represents an increase over the 1994 data. The increase in average weight is due to an increase in common carp captured in 1995. The 1995 data for numbers and weight are similar to past reported fluctuations and remains within historical ranges (Figure 3.3-4).

When lake gill netting and electrofishing data are combined for selected species and examined for size class distribution, the data indicate certain population trends. The largemouth bass population has remained relatively stable during the last three years and is similar to historical data (Virginia Power 1989-94). The 1995 results indicate a slight decrease in YOY class for largemouth bass, a decrease in intermediate class numbers, and the harvestable class remained unchanged (Figure 3.3-5).

A similar comparison for bluegill is provided in Figure 3.3-6. The 1995 data for bluegill indicate a decrease in YOY while intermediate bluegill remained the same, and harvestable fish increased.

A 1995 statistical analysis was completed to determine if hydrilla colonization in the WHTF was having any effect on the length-weight relationship of largemouth bass in the WHTF. An analysis of co-variance indicated that there was a statistical difference in the length-weight relationship for the pre-hydrilla period (1981-1986) and post-hydrilla period (1990-1995). The analysis showed that bass 200 mm or less in length from the post-hydrilla period were heavier than bass of the same size from the pre-hydrilla period. Conversely, post-hydrilla bass 200 mm or greater in length weighed less when compared to pre-hydrilla bass 200 mm or greater (Figure 3.3-7).

A further analysis of the length frequency data for largemouth bass captured in the WHTF indicates a similar pattern in length frequencies for the post-hydrilla period from 1990 to 1994 when compared to the post hydrilla data for 1995 (Figure 3.3-8). These data indicate the 200mm class to be the greatest percentage collected, followed by the 100mm class. The data for 1995, following a collapse of hydrilla in both the lake and WHTF, indicate a similar length-frequency distribution for bass collected in the WHTF. The presence of hydrilla has been shown to increase habitat complexity and thus provide cover for the smaller YOY bass (and other species also). The increase in habitat complexity may also result in decreased prey capture by larger piscivorous fish. Each of these acting in concert tend to reduce growth and stockpile intermediate-length classes. This condition has been reported in other studies related to the presence of hydrilla at Lake Conroe (Bettoli et al 1992) and Guntersville Reservoir (Wrenn et al, 1995).

When the data for bluegill in the WHTF are examined using the same parameters, a slight population shift is observed in the 1995 data (Figure 3.3.9). In the post-hydrilla period from 1991 to 1994 the most numerous length class is 60mm, with the 80mm and 40 mm classes being second and third respectively. In the 1995 data, the most numerous length class is the 80mm class with 100mm class second and the 60mm class third. This slight shift in length class is probably the result of a decrease in hydrilla in the WHTF in 1995 and subsequent elimination of cover for the smaller length classes. Population shifts of this type have been documented in the literature in other large lake systems colonized by hydrilla. (Colle et al, 1980).

Lake Anna was again the leader in Virginia in number of citations of largemouth bass (bass weighing more than 3.6 kg) with 102 citation bass being reported by anglers in 1995.

3.4 Aquatic Vegetation

Hydrilla is an exotic, submerged, aquatic macrophyte which, in most bodies of water, has the ability to grow and spread rapidly. The primary method of reproduction is by vegetative means through fragmentation. Hydrilla also produces overwintering structures in two (2) separate areas of the plant: Tubers, produced by the roots in the hydrosoil; and turions, formed at the leaf axils of the plant. Each has the ability to produce new plants at the beginning of each new growing season. Hydrilla was first documented in Lake Anna in 1987.

The lake hydrilla acreage decreased from 832 acres in 1994 to 14 acres in 1995 (Table 3.4-1). The 1994 total of 832 acres represented 21% of the maximum available habitat (areas of 15 feet or less, water depth). This percentage was reduced to 0.3% in 1995. There were no areas of hydrilla reported in the upper lake, with the reported 14 acres occurring in the lower lake (Figure 3.4-1). The 1995 hydrilla survey data for the WHTF also indicate a decrease from 897 acres to 10.1 acres (Figure 3.4-2, 3, and 4).

The decline of hydrilla is probably the result of several factors:

- The introduction of the triploid grass carp in the WHTF in June 1994 has resulted in reduced biomass of hydrilla.
- The early part of the growing season (April and May) was marked by above average rainfall resulting in lower water temperatures and increased turbidity (decreased light penetration). Studies have shown each of these processes can delay the growing season for hydrilla (Barko, 1981).

- Another factor believed to be responsible for the hydrilla reduction in the lake was a very localized and powerful storm which produced record setting rainfall in the watershed feeding into Lake Anna. The storm resulted in a one hour record of 5.67 inches of rain recorded in Orange, Virginia on June 27, 1995 (National Weather Service records) which produced severe flooding and erosion above Lake Anna. Resultant silt and turbidity in the lake probably reduced the light penetration and further hindered hydrilla growth.

3.5 Conclusions

1995

- North Anna Power Station during 1995 operated at or above generation levels for 1994.
- The 1995 water temperature data from the continuous recorders indicated water temperatures similar to those recorded in 1994.
- Thermal stratification patterns measured in quarterly surveys in 1995 indicated similar stratification patterns to previously reported data.
- Gill netting surveys during 1995 produced numbers less than 1994 yet weight totals greater than 1994, but both within historical ranges.
- Electrofishing surveys during 1995 produced numbers and weights greater than those of 1994.
- Hydrilla acreage for 1995 decreased in both the lake and in the WHTF.

4.0 North Anna River

4.1 Temperature

Water temperatures (°C) were recorded hourly at two stations, NAR-1 and NAR-3, in the lower North Anna River during 1995 (Figure 4.1-1) using fixed Endeco model 1144SSM temperature recorders. The two stations are separated by approximately 17 km. Monthly records are incomplete for October through December at NAR-1, and January - April, and August - December, at NAR-3 because of instrument malfunction or damage.

Water temperatures were highest from June through September during 1995 when mean monthly water temperatures exceeded 25°C (Table 4.1-1). A maximum hourly temperature of 32.1° C was recorded at NAR-1 in July 1995. Historically, maximum water temperatures have occurred in July or August (Virginia Power 1992). A minimum hourly temperature of 4.1° C was recorded at NAR-3 in January 1995, and is similar to historical minimum water temperatures.

River discharge (cfs) data were obtained from the United States Geological Survey to document the timing and magnitude of hydrologic events. These events, along with water temperature, are among the most significant abiotic factors affecting the abundance and distribution of stream organisms. Data were obtained for the gage near Partlow, Virginia, located approximately 1 km downstream of the Lake Anna dam at NAR-1 (Figure 4.1-1).

The pattern of seasonal flows in the North Anna River is generally characterized by high flows in the winter and spring, reduced flows during summer, and very low flows during late summer and early autumn. This is a pattern commonly exhibited by many rivers draining the eastern United States, and is reflective of the annual rainfall pattern. In 1995, North Anna River flows for February - April were exceptionally high, frequently exceeding 1,000 cfs. Mean monthly flows exceeded 1,500 cfs in March, and 1,000 cfs in February and April. Prolonged flows exceeding 1,000 cfs are uncommon in the North Anna River. For the period 1981-1993, mean monthly flows exceeded 1,000 cfs on only five occasions (Virginia Power 1993). Following high flows early in 1995, flows decreased to near minimum levels (40 cfs) by June. The period July through September was unusual in that flows generally exceeded minimum levels, and a summer flood with a mean daily discharge of 3,940 cfs occurred in August. After September, flows remained at or slightly above minimum for the remainder of the year. USGS data were not available for November due to a gage malfunction. However, dam records indicated flows were at or near minimum flow throughout November.

4.2 Fish Population Studies-Electrofishing

Abundance and species composition data for the North Anna River fish assemblage were collected during electrofishing surveys. Consistent sampling techniques have been used in all North Anna River electrofishing surveys conducted since 1981.

In 1995, electrofishing surveys were conducted in May, August, and September.

Sampling was conducted in August instead of June, as in most previous years, because high water prevented sampling June and July events. During each survey, four (4) stations were sampled; NAR-1, NAR-2, NAR-4, and NAR-6 (Figure 4.1-1). An approximately 70-m reach of riffle/run type habitat was sampled at each station with an electric seine (Virginia Power 1986). Each 70-m reach was sampled in two sections that were blocked at the downstream ends with a 6.5-mm mesh net prior to sampling. Sampling was conducted by working the electric seine from bank to bank in a zigzag pattern from the upstream to the downstream end of each section. Nearby pool type habitats were then sampled for 10 minutes of effort with a backpack electrofisher. Fish sampled by electric seine and backpack electrofisher were collected using 6.5-mm mesh dip nets.

Most fish collected were preserved in 10% formalin, and transported to the Ecological Studies Laboratory in Ashland, Virginia. Some larger fish were weighed and measured in the field and released. A maximum of 15 specimens of each species was weighed and measured to the nearest 0.1 g and measured to the nearest 1 mm total length (TL). If more than 15 specimens of a species were collected, those in excess of 15 were counted and weighed in bulk. Electric seine and backpack electrofisher collections were pooled by station and survey month for analyses in 1995, as in every year since sampling in a consistent manner began in 1981.

A total of 1,060 fish was collected from the North Anna River during electrofishing surveys conducted in 1995 (Table 4.2-1). The 1995 total was the third-lowest number of fish collected since sampling in a consistent manner began in 1981 (Figure 4.2-1). In 1989, the year in which the lowest number of fish was collected, only one sample could be collected due to high flows (Virginia Power 1990). In 1993, the year in which the second-lowest number of fish was collected, a full complement of samples was collected (Virginia Power 1995). In 1995, NAR-1 yielded the greatest numerical catch followed by, in decreasing order, NAR-2, NAR-6, and NAR-4 (Table 4.2-1). NAR-1 yielded the highest biomass in 1995, followed by, in decreasing order, NAR-4, NAR-2, and NAR-6.

High winter and spring flows have often resulted in decreased North Anna River electrofishing catches. In 1993, the relationships between flow and annual fish abundance were examined. Results of Spearman's correlation analysis (Hollander and Wolfe 1973) indicated low late winter/early spring flows tend to be conducive to a relatively high electrofishing catch later in the year, whereas high flows early in the year tend to result in low electrofishing catches (Virginia Power 1995).

It was hypothesized that February and March flows may influence annual fish abundance because high flows increase mortality of fish that are already stressed from overwintering. Numbers of fish and biomass of fish collected in 1995 were similar to totals for 1993 (Virginia Power 1995). Exceptionally high flows also occurred during late winter/early spring in both years. The high flows experienced February through March 1995, mentioned in section 4.1 of this report, appeared to have to have had adverse effects on the fish assemblage, similar to 1993 (Virginia Power 1995).

Twenty-five species of fish representing eight families were collected from the North Anna River in 1995 (Table 4.2-1). Over the past 13 years a total of 48 species has been collected from the North Anna River (Table 4.2-2), and annual totals have ranged from 25 to 32 species. In 1995 the hogchoker Trinectes maculatus was added to the list of species collected from the North Anna River. One specimen, 56 mm TL, was collected by electric seine from NAR-6 during the August survey. The hogchoker is a common inhabitant of brackish waters along the Virginia coast. The individual collected from the North Anna River was probably a temporary summer migrant. During summer 1993, another hogchoker of similar size was collected from NAR-6 as part of an equipment test, indicating the hogchoker collected in 1995 was not an anamoly.

A common characteristic of stream systems is the tendency for a few species to numerically dominate the stream fish assemblage (Matthews 1982). Six to 10 species have accounted for greater than 80 percent of the North Anna River electrofishing catch from all stations in any year since sampling began in a consistent manner in 1981 (Table 4.2-3). In 1995, seven species accounted for greater than 80 percent of all fish collected. These were, in decreasing order, redbreast sunfish Lepomis auritus, swallowtail shiner Notropis procne, rosyface shiner N. rubellus, margined madtom Noturus insignis, shield darter Percina peltata, satinfin shiner Cyprinella analostana, and American eel Anquilla rostrata. These species have consistently been among the most abundant species collected from the North Anna River since 1981 (Table 4.2-3).

4.3 Fish Population Studies- Direct Observation

Abundance and distribution data for smallmouth bass and largemouth bass were gathered via direct observation during snorkel surveys. Consistent observation techniques have been used in snorkel surveys since 1987; however, sampling frequency at some stations has varied among years. Historical trends were examined for all years with comparable sampling methods.

In 1995, snorkel surveys were conducted during July, August, and September. Four (4) stations were sampled; NAR-1, NAR-2, NAR-4, and NAR-5 (Figure 4.1-1). Each station was sampled twice each month. Abundance estimation procedures were identical to those employed since 1987 (Virginia Power 1988). Counts of smallmouth bass (SMB) and largemouth bass (LMB) were made while swimming 100 m transects along the north and south banks of each station. Transects followed an approximately 1 m depth contour.

All bass sighted were categorized by species as to YOY ($\leq$120 mm), stock-size (120<SMB<280 mm or 120<LMB<305 mm), or quality-size (SMB$\geq$280 mm or LMB$\geq$305 mm). In addition to size group, all bass sighted were categorized as to type of cover being used; bedrock ledge (Ledge), boulders (Boulder), instream woody debris (Wood), aquatic vegetation (Vegetation), or no apparent cover use (Open). Fish had to be within 0.5 m of a cover object at the moment of sighting to be included in a cover use category other than the Open category. Aquatic vegetation was included as a cover type beginning in 1993 due to annual increases in the amount of vegetation observed from 1990 through 1992, and apparent increased use by fish.

During each station survey, three successive counts were made at each bankside transect. Each observer made an independent estimate of the distance that YOY smallmouth bass (TL≤120 mm) could be distinguished from YOY largemouth bass (TL≤120 mm) at each station. Lateral visibility at each station was estimated by averaging the independent estimates of both observers. Counts of smallmouth bass and largemouth bass were converted to density estimates (number/hectare of bankside channel) to account for differences in average visibility among survey days and sampling stations. Density estimates for all smallmouth bass and largemouth bass larger than YOY size were pooled by species, station, and sample year to facilitate identification of species-specific and station-specific changes over time. Calculations of median density estimates by sample year and associated 95% confidence intervals were based on Walsh averages (Hollander and Wolfe 1973). YOY densities were not calculated as it was doubtful that YOY were as susceptible to the observation technique as were larger fish, due to their small size and cryptic nature.

Cover utilization data from the first of three sets of observations obtained during each snorkel survey were used to examine differences in cover use by smallmouth bass and largemouth bass. Data from only the first count were used because it was assumed fish observed during the first count would be relatively undisturbed by divers, whereas fish observed on the second and third counts may have changed their positions in response to divers passing by during the first count.

Snorkel surveys for 1995 were conducted between 0900 and 1450 hours at river temperatures ranging from 20.2 to 28.0° C and average visibilities ranging from 1.25 to 3.00 m. Similar to previous years, smallmouth bass were most frequently observed at the downstream station NAR-5 (Table 4.3-1). Largemouth bass were most often observed at the upstream stations NAR-1 and NAR-2 in 1995 (Table 4.3-1), also similar to previous years. Variability between the north and south bank at any station appeared to be related to habitat complexity, i.e., fewer fish were observed along banks characterized by monotypic habitat than along banks with a variety of habitat types.

Observations of relatively high numbers of YOY smallmouth bass and largemouth bass (Table 4.3-1) indicated reproductive efforts by these species were successful in 1995. Young-of-year smallmouth bass and largemouth bass were generally most abundant at those stations where juveniles and adults (fish > 120 mm TL) of each species have historically been abundant (Table 4.3-1). Young-of-year largemouth bass were especially abundant at NAR-1 in 1995. Observations of YOY smallmouth bass at NAR-1 and NAR-2 indicate the established smallmouth bass population within this reach is persisting (Virginia Power 1995). Density estimates indicated juvenile and adult smallmouth bass density remained low at NAR-1 in 1995, whereas juvenile and adult largemouth bass density was comparable to 1993 (Figure 4.3-1). It is interesting to note that combined density for both Micropterus species has remained relatively high and constant at NAR-1 since 1991, and that annual density estimates for the two species have varied in an opposite manner. A similar relationship is apparent for smallmouth bass and largemouth bass densities at NAR-2. At NAR-4, smallmouth bass and largemouth bass density levels in 1995 were similar to those of 1993 and most previous years (excepting 1991, when density levels for both species increased sharply). Largemouth bass density decreased at NAR-5, but smallmouth bass exhibited a sharp increase in density following a two year decline.

Observations of cover use by smallmouth bass and largemouth bass are difficult to interpret without accounting for the availability of various cover types. For this reason, cover use data obtained in 1995 are primarily presented for documentation purposes (Table 4.3-2). However, two aspects of the pooled 1995 cover use data deserve mention. One is the high frequency with which largemouth bass were observed in association with woody debris and vegetation (Table 4.3-3). The North Anna River snorkel surveys have demonstrated that largemouth bass exhibit a consistently strong preference for woody cover. With recent increases in the abundance of aquatic vegetation in the lower North Anna River, largemouth bass appear to be shifting from making nearly exclusive use of woody debris to dividing their use between woody debris and aquatic vegetation.

Also noted in 1995 were differences in cover use by YOY smallmouth bass and largemouth bass. In 1995, woody debris and vegetation were most often used by YOY largemouth bass, whereas YOY smallmouth bass used all cover types (excepting vegetation) and open water with approximately equal frequencies. Although the number of observations for 1995 and previous years are low, similar differences were seen in 1992 and 1993, i.e., YOY largemouth bass made frequent use of aquatic vegetation, whereas no YOY smallmouth bass were observed within 0.5 m of aquatic vegetation (Virginia Power 1993). These observations suggest that YOY largemouth bass and smallmouth bass may segregate by habitat type.

4.4 Other Studies

In 1995, researchers from Virginia Tech continued studies initiated in 1991 of the biological responses of fish populations in the North Anna River to variations in stream flow. Oak Ridge National Laboratory coordinates this research, which is sponsored by the Electric Power Research Institute (EPRI) as one part of an effort to improve models for use in determining instream flow needs. Virginia Power has provided support for graduate studies being conducted on the North Anna River. One graduate student from Virginia Tech, Ed Pert, concluded his Doctor of Philosophy research projects related to competitive interactions between smallmouth bass and redbreast sunfish in 1995. Analysis of the results of this work is ongoing. Master of Science candidate Ladd Knotek continued field studies and analysis of factors affecting YOY smallmouth bass survival in 1995.

Scientists at Oak Ridge National Laboratory have used the results of these studies to develop and refine models designed to simulate responses of smallmouth bass to changes in flow. Cooperation among Virginia Tech, Virginia Power, and other biologists involved with the EPRI project has facilitated the transfer of valuable information to all of the groups involved, and to the general public. Recent and pending publications resulting from the Virginia Tech and Oak Ridge National Laboratory on the North Anna River include Groshens and Orth (1995), Jager et al. (1993), Lukas and Orth (1993), and Sabo and Orth (1995a), (1995b), and (1995c).

4.5 Conclusions

1995 Studies

- Electrofishing surveys conducted in 1995 found numbers and biomass of fish collected to be similar to those of 1993, but reduced from previous years. Exceptionally high flows occurring in February and March are believed responsible.

- Species composition of the electrofishing catch in 1995 was similar to previous years. Seven species comprised 85% of the electrofishing catch in terms of numbers of fish collected, and six species comprised 80% of the electrofishing catch in terms of biomass.

- Underwater observations of smallmouth bass and largemouth bass made in 1995 indicated smallmouth bass dominated the lower reaches of the North Anna River, and largemouth bass dominated the upper reaches, similar to previous years.

- Density estimates for juvenile and adult smallmouth bass and largemouth bass determined in 1995 were generally similar to those of recent years. Increased smallmouth bass density at NAR-5 was the only notable change from recent years.

- Observations of cover use made in 1995 and previous years indicated smallmouth bass and largemouth bass may segregate by habitat type.

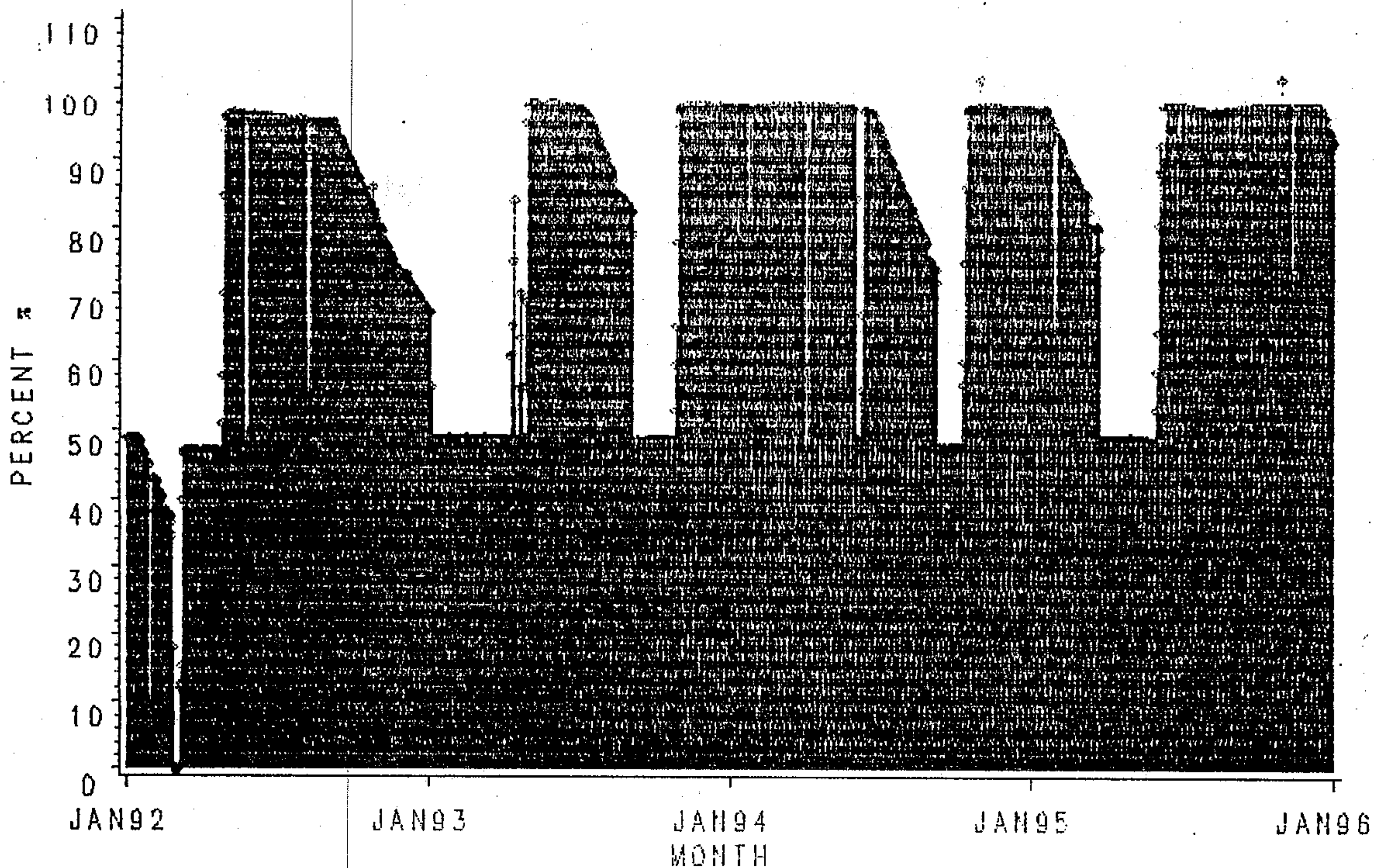
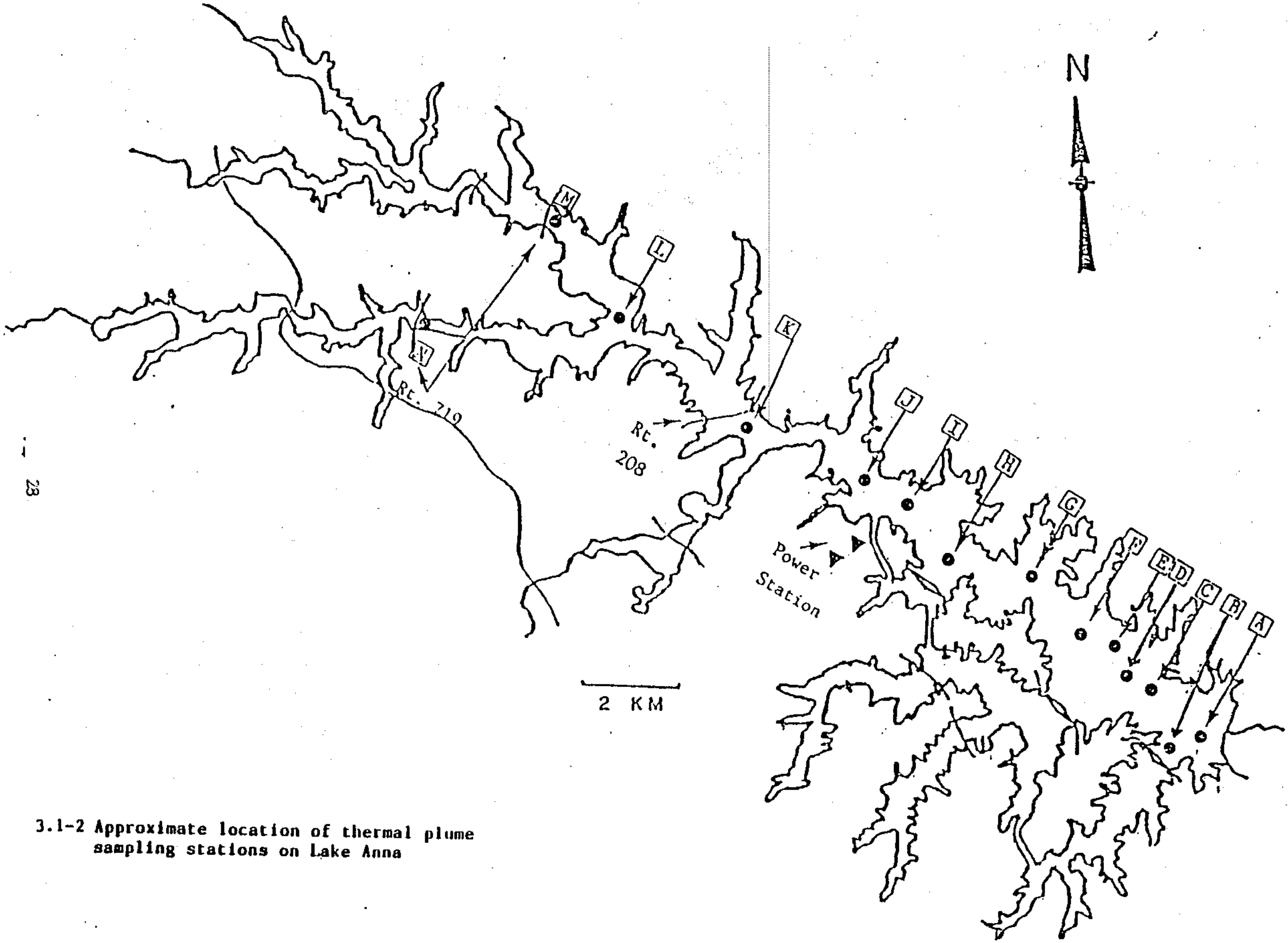
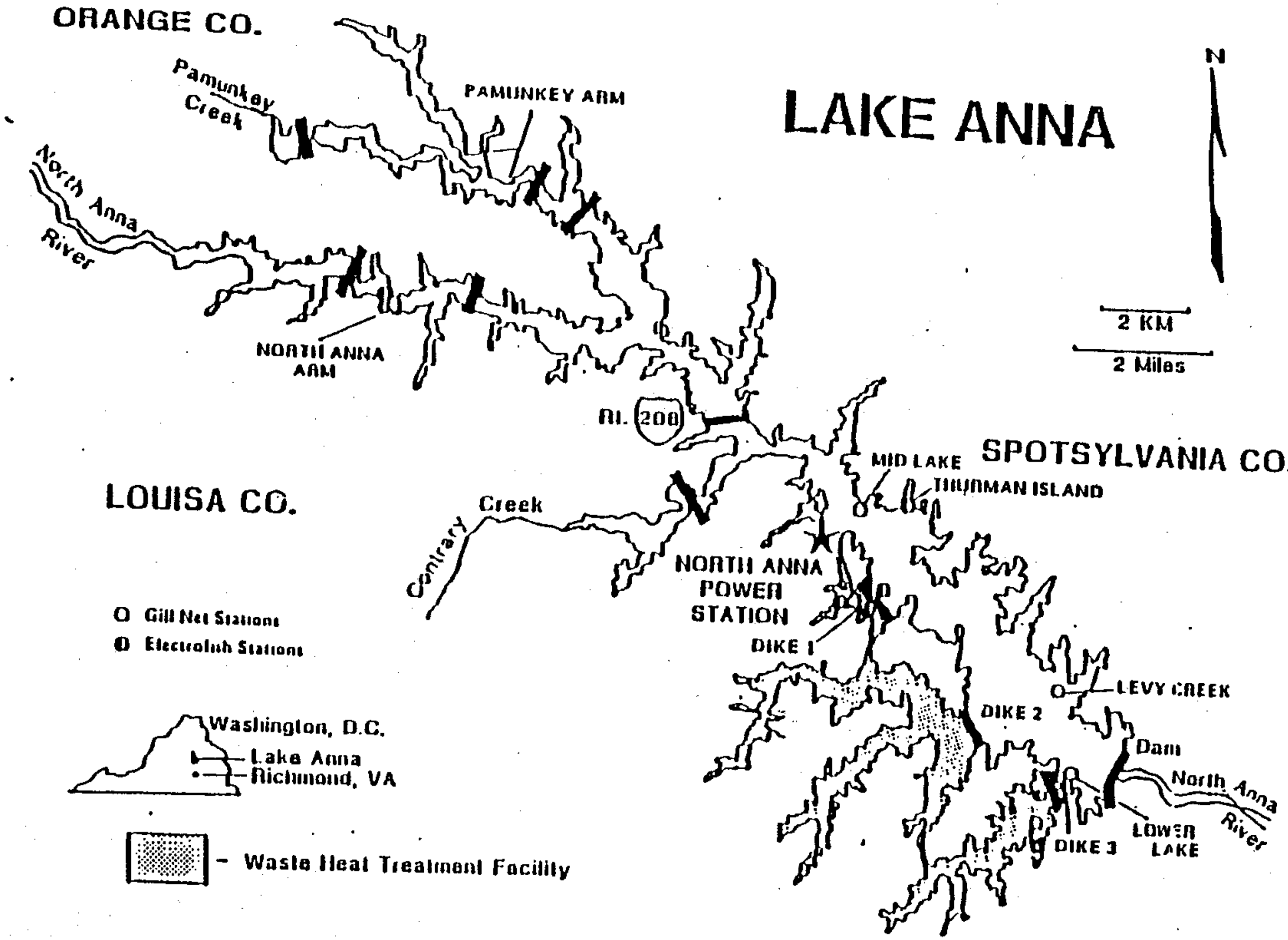


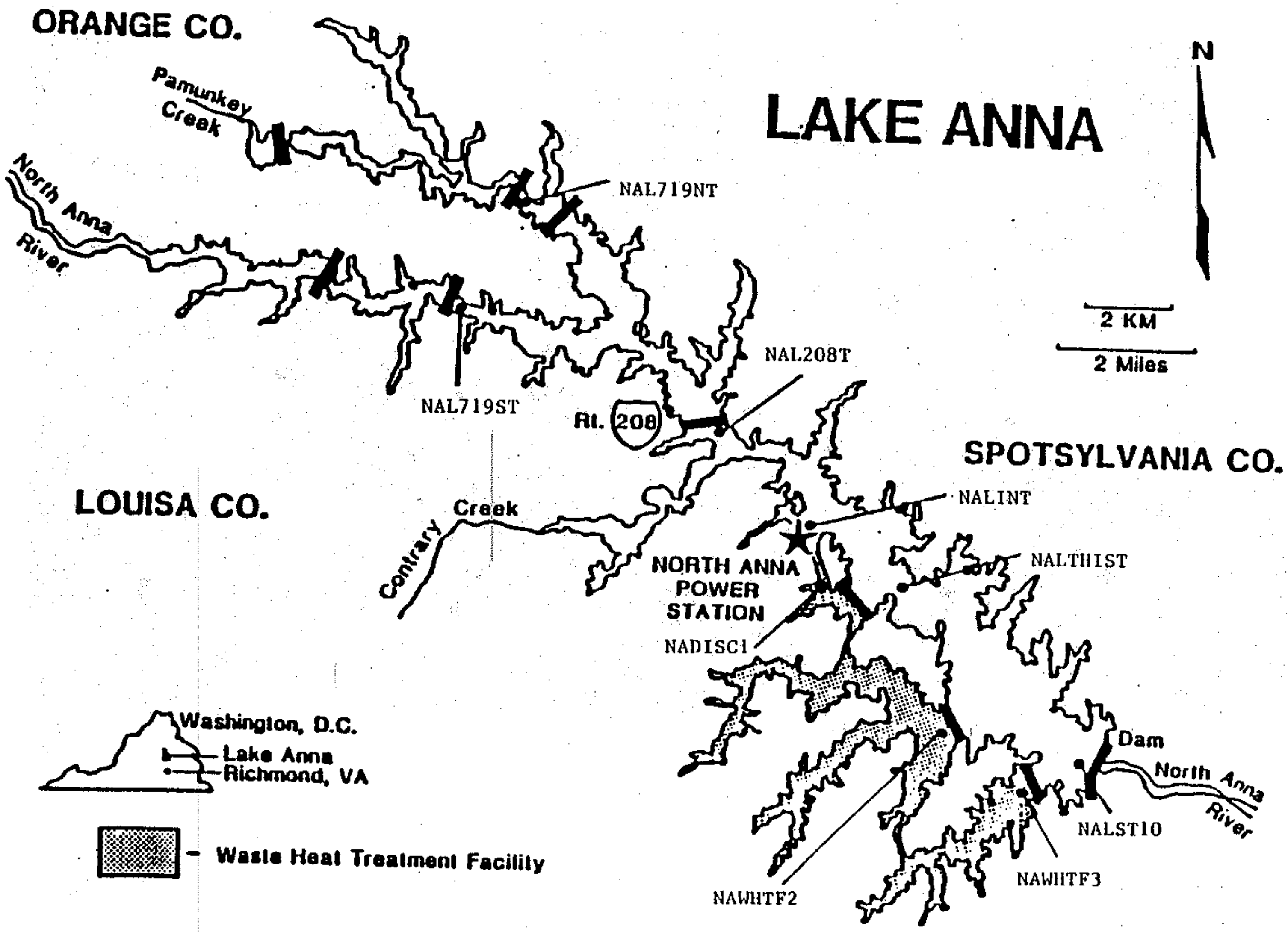
FIGURE 2.0−1. 1992−1995 NORTH ANNA UNITS 1 & 2 DAILY POWER LEVEL



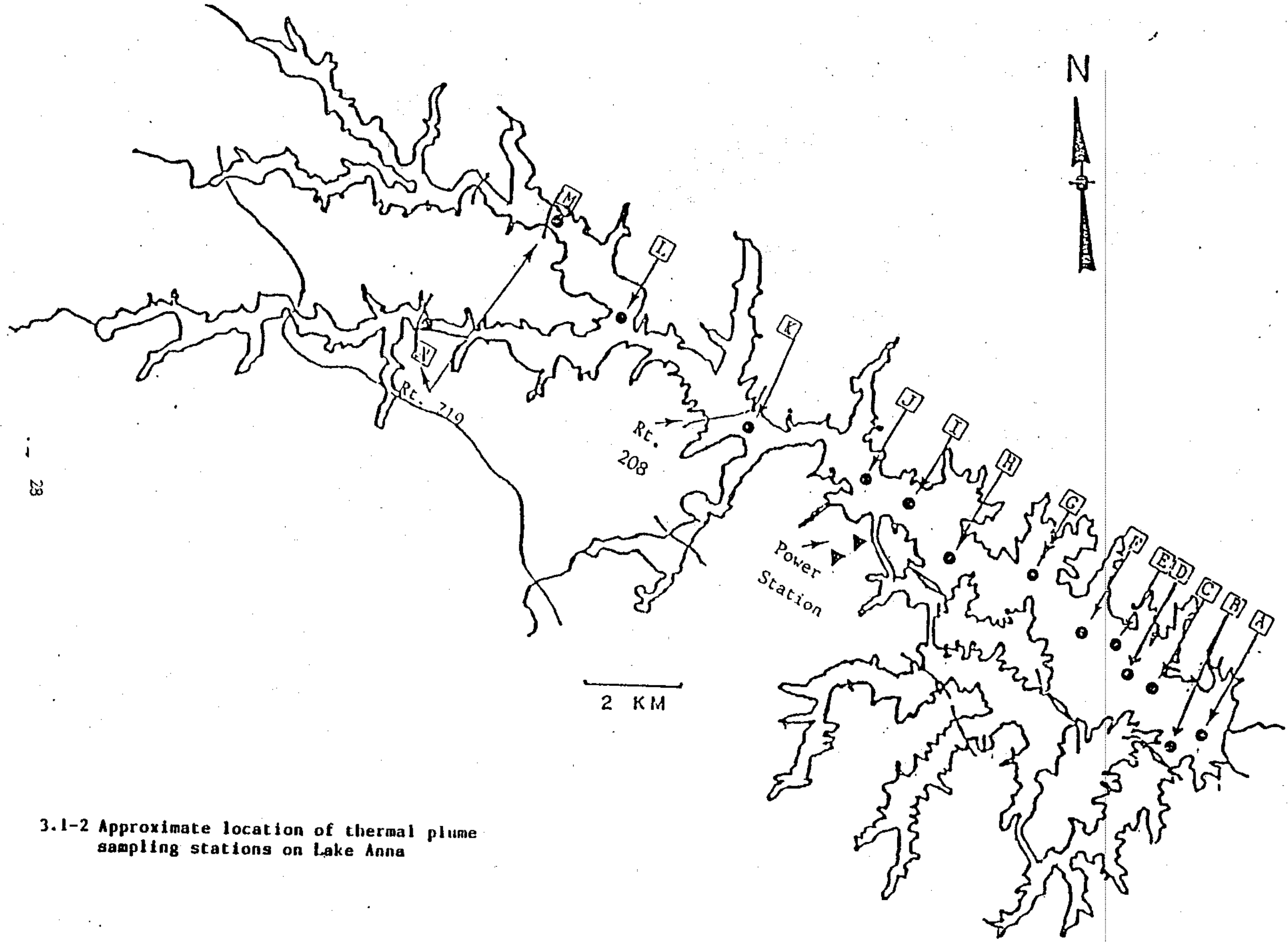
3.1-2 Approximate location of thermal plume sampling stations on Lake Anna



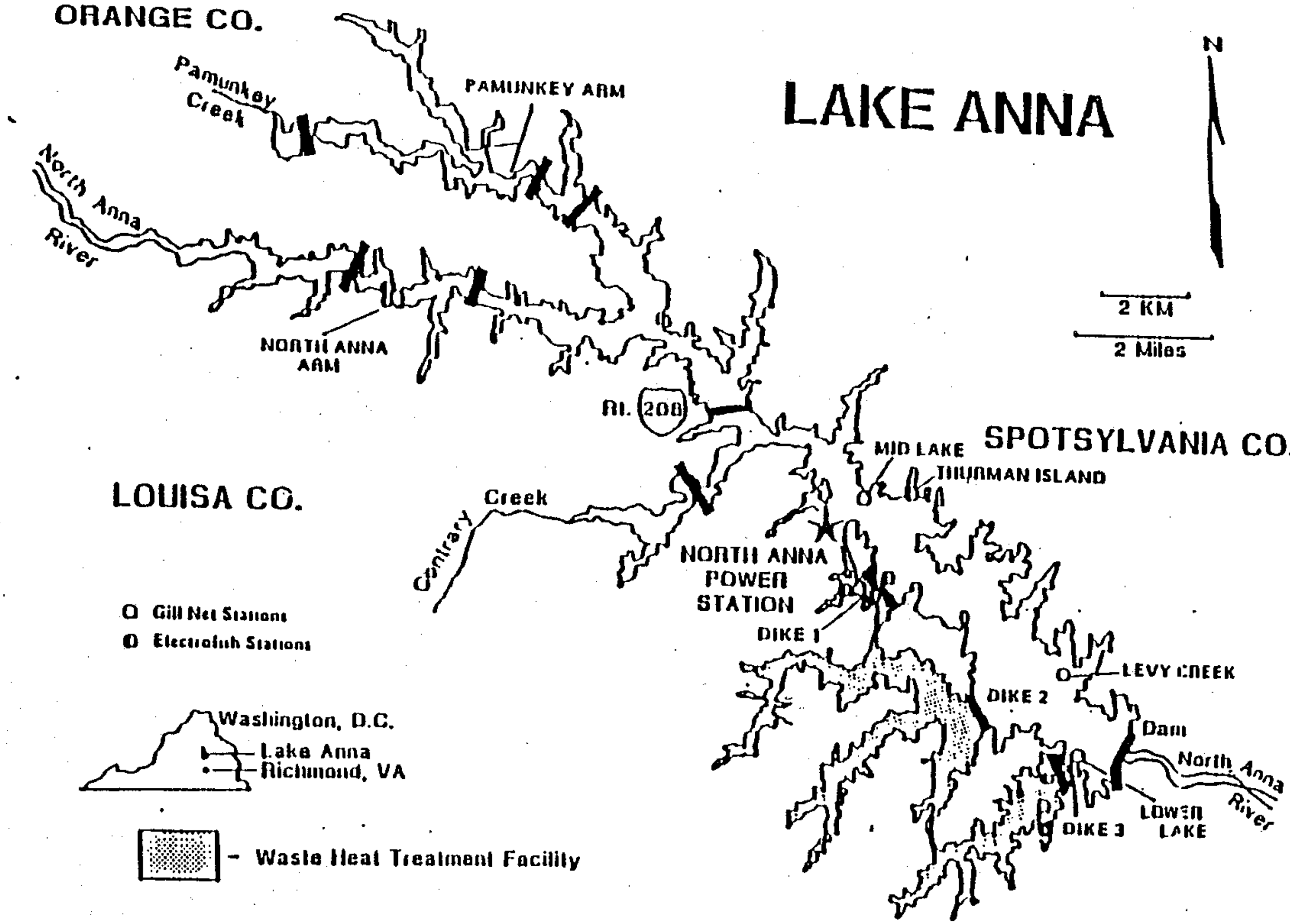
3.2-1 Location of electrofish and gill net stations.



3.1-1 Approximate locations of fixed Endeco temperature recorders on Lake Anna.

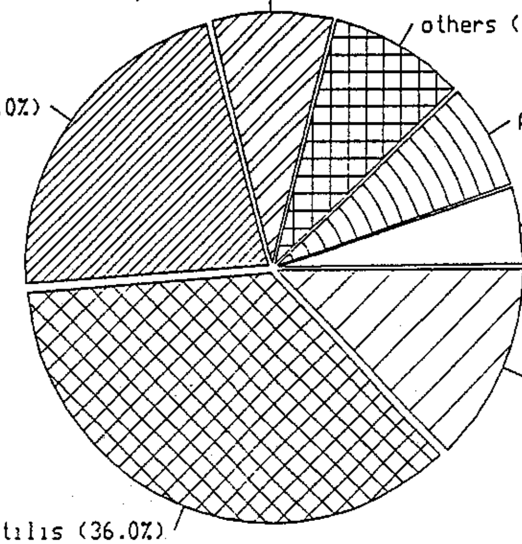


3.1-2 Approximate location of thermal plume sampling stations on Lake Anna



3.2-1 Location of electrofish and gill net stations.

FIGURE 3.2-2 GILL NET RESULTS
LAKE 1995
(% BY WEIGHT)



GILL NET RESULTS
LAKE ANNA 1995
(% BY NUMBER)

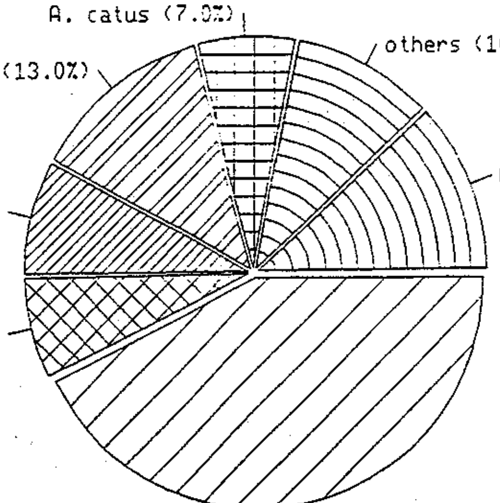


FIGURE 3.2-3 COMPOSITION OF GILL NET DATA FOR LAKE ANNA AND WHTF (1990-1995)

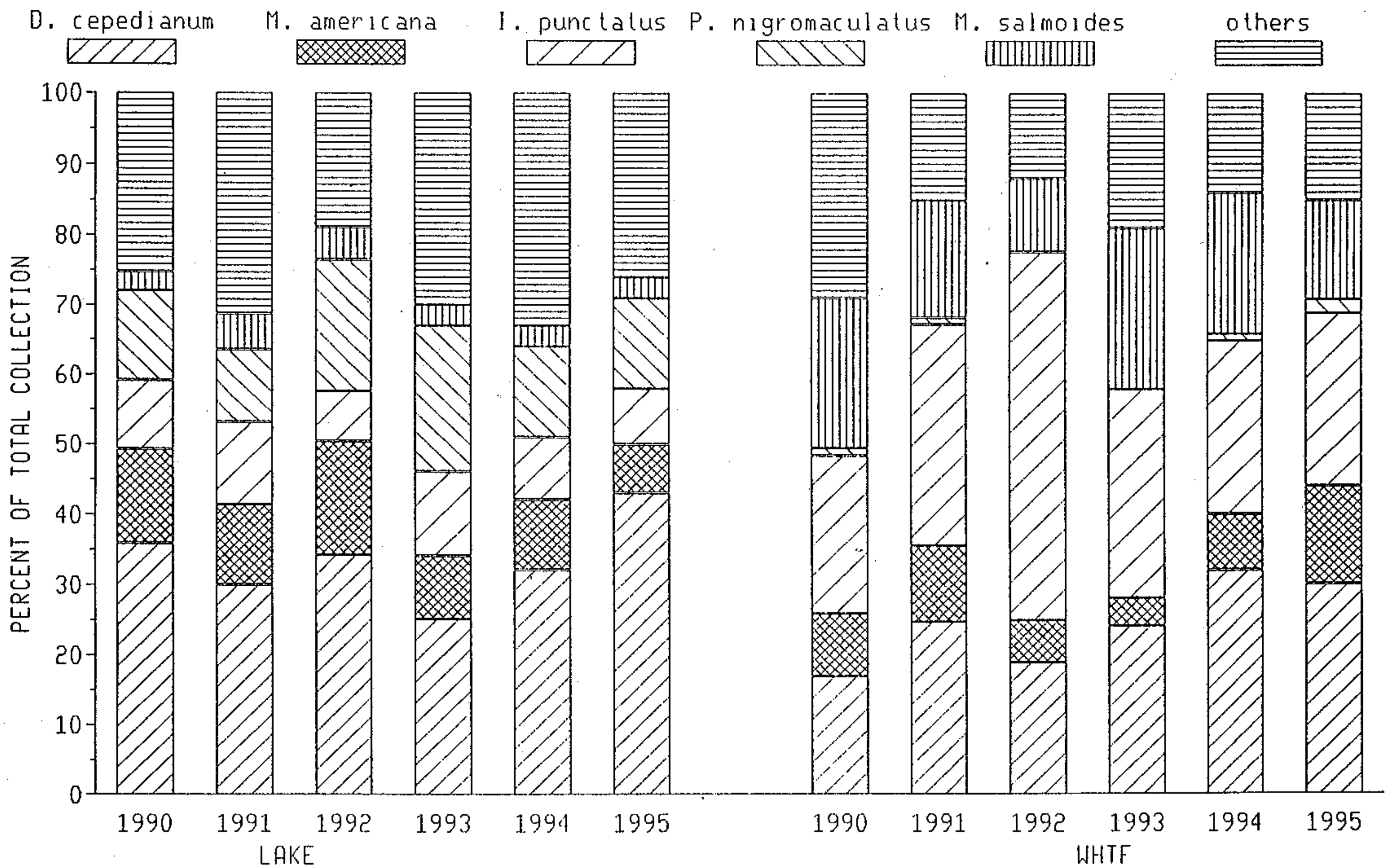
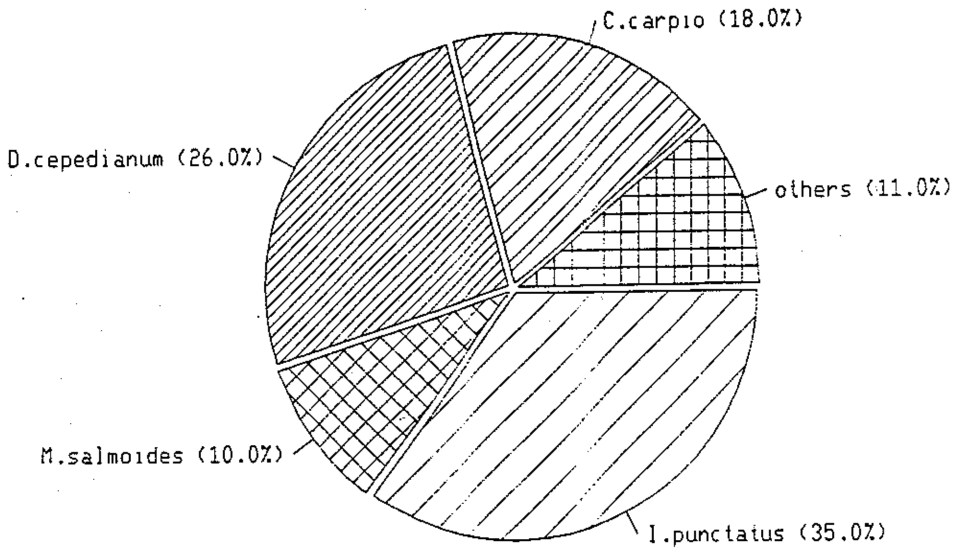


FIGURE 3.2-4 GILL NET RESULTS

WHTF 1995

(% BY WEIGHT)



GILL NET RESULTS

WHTF 1995

(% BY NUMBER)

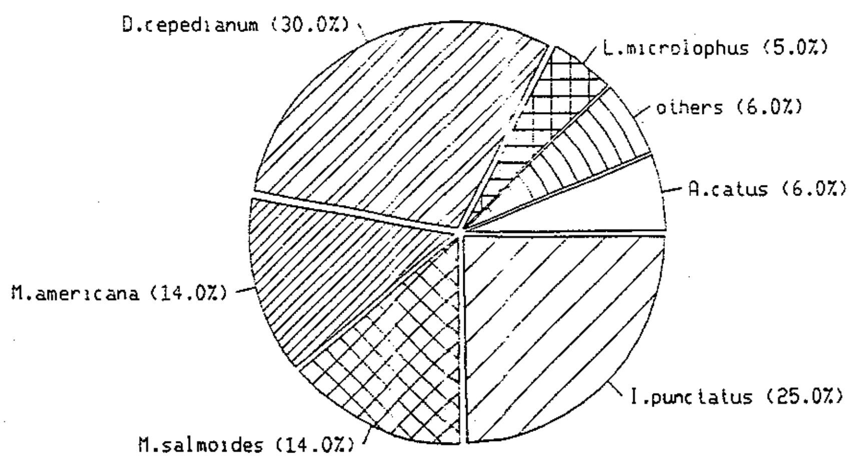


FIGURE 3.2-5 CATCH PER UNIT EFFORT
ELECTROFISH & GILL NET COLLECTION
Lake Anna, 1981 - 1995

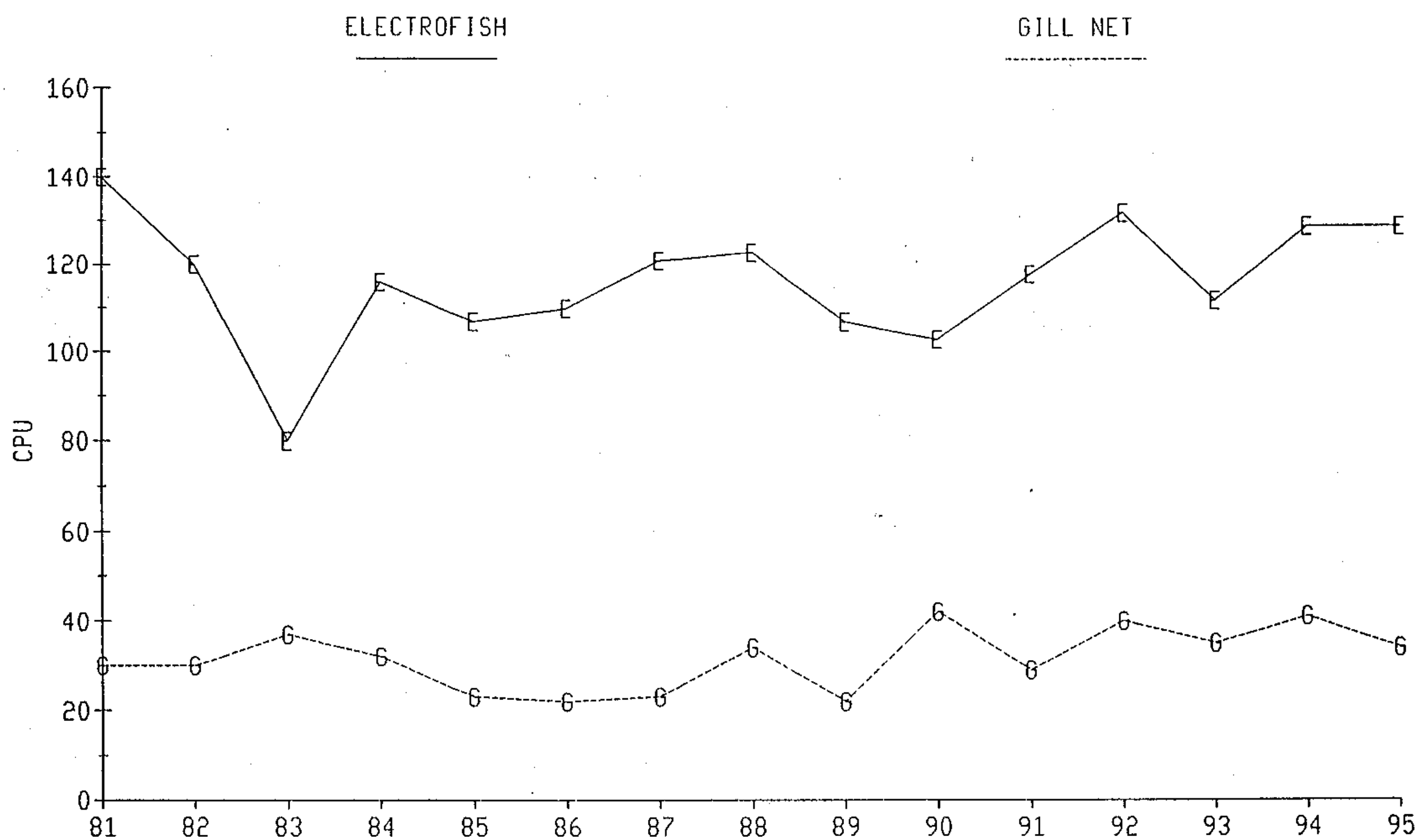


FIGURE 3.2-6 LAKE ANNA GILL NET DATA (1981-1995)
AVERAGE NUMBER AND AVERAGE WEIGHT PER YEAR

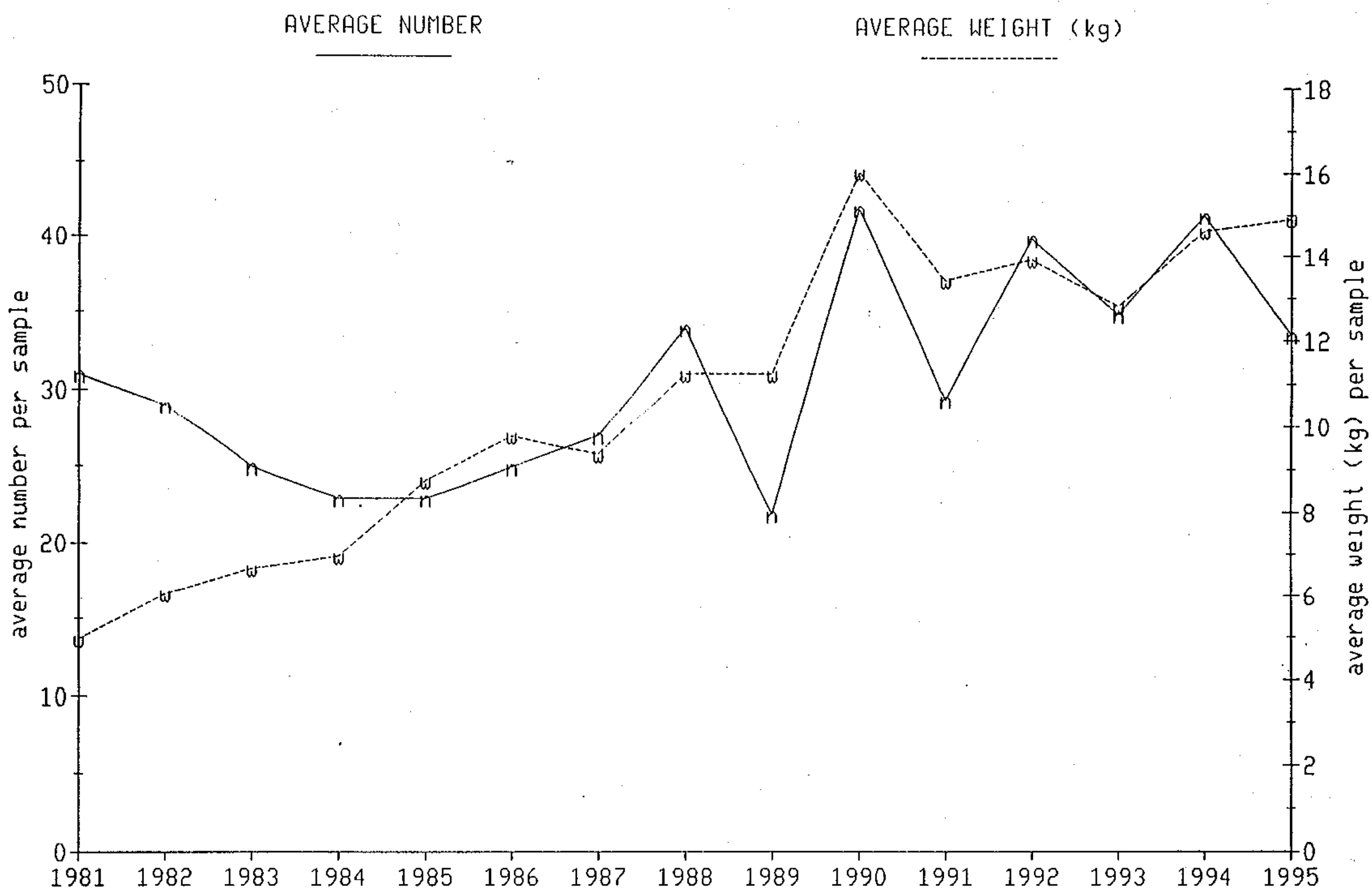
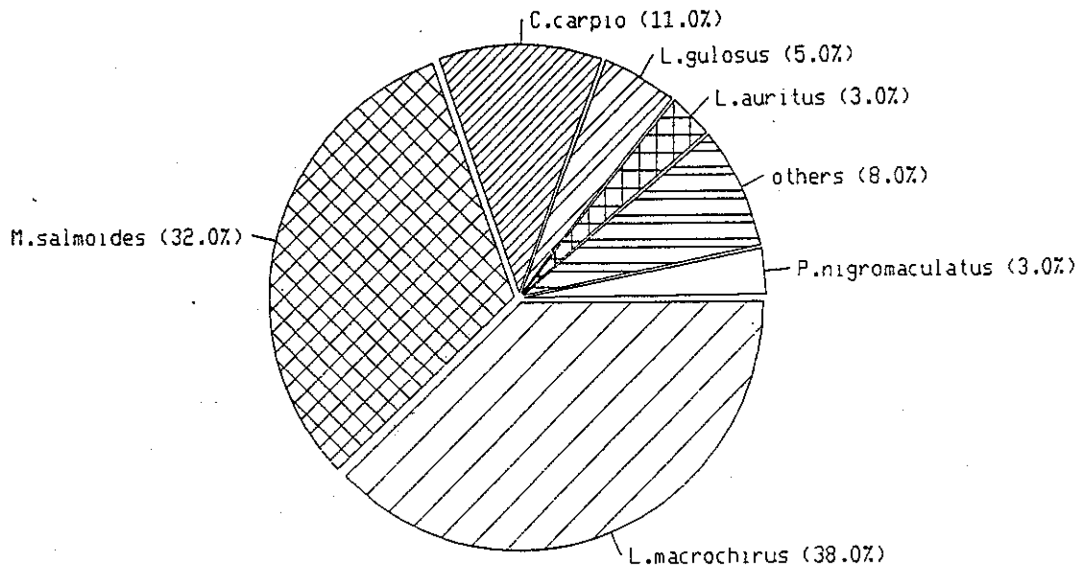


FIGURE 3.3-1. ELECTROFISH RESULTS

LAKE ANNA 1995

(% BY WEIGHT)



ELECTROFISH RESULTS

LAKE ANNA 1995

(% BY NUMBER)

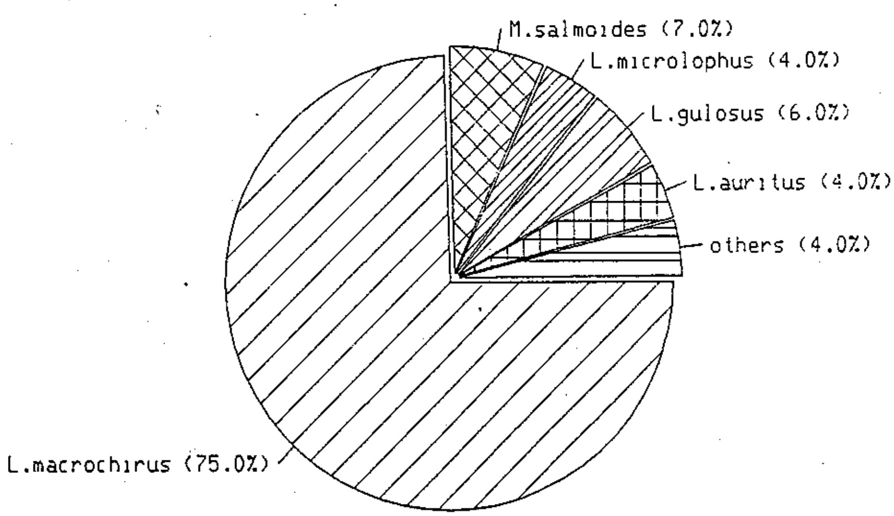
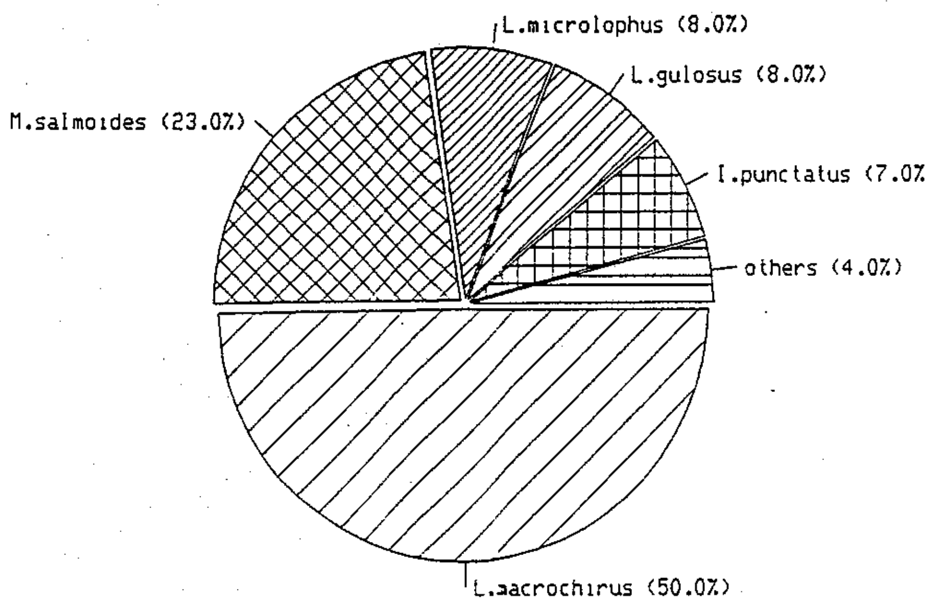


FIGURE 3.3-2. ELECTROFISH RESULTS
WHTF 1995
(% BY WEIGHT)



ELECTROFISH RESULTS
WHTF 1995
(% BY NUMBER)

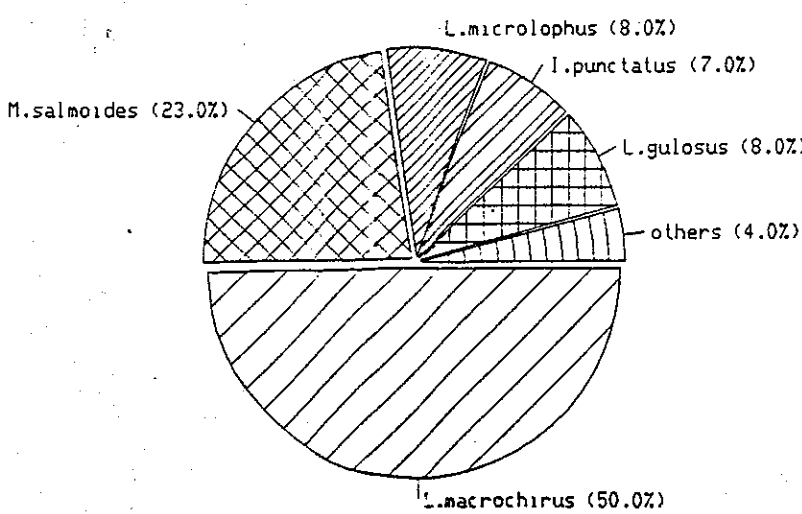


FIGURE 3.3-3 .COMPOSITION OF ELECTROFISHING DATA FOR LAKE ANNA AND WHTF, (1990-1995)

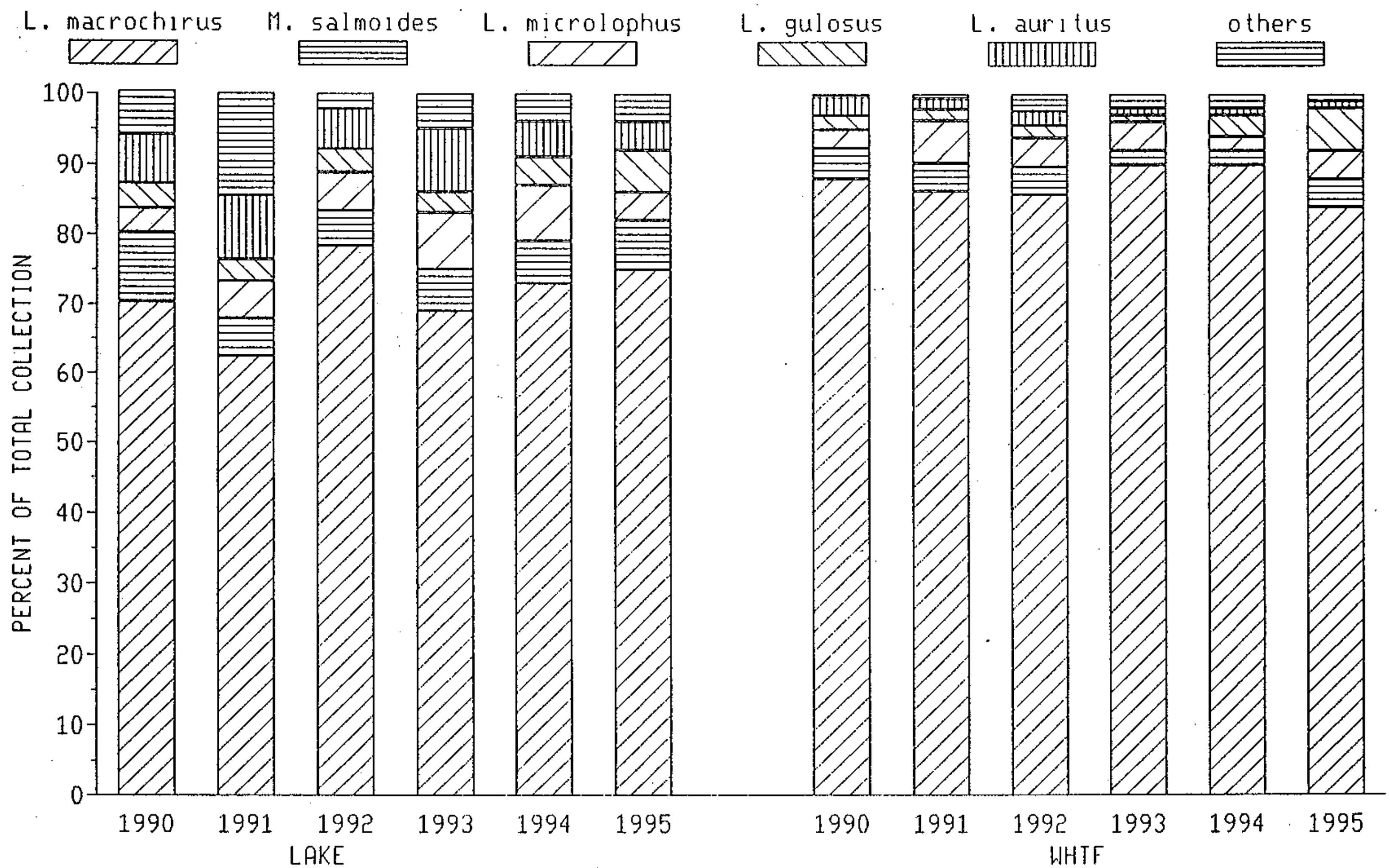


FIGURE 3.3-4 LAKE ANNA ELECTROFISH DATA (1981-1995)
AVERAGE NUMBER AND AVERAGE WEIGHT PER YEAR

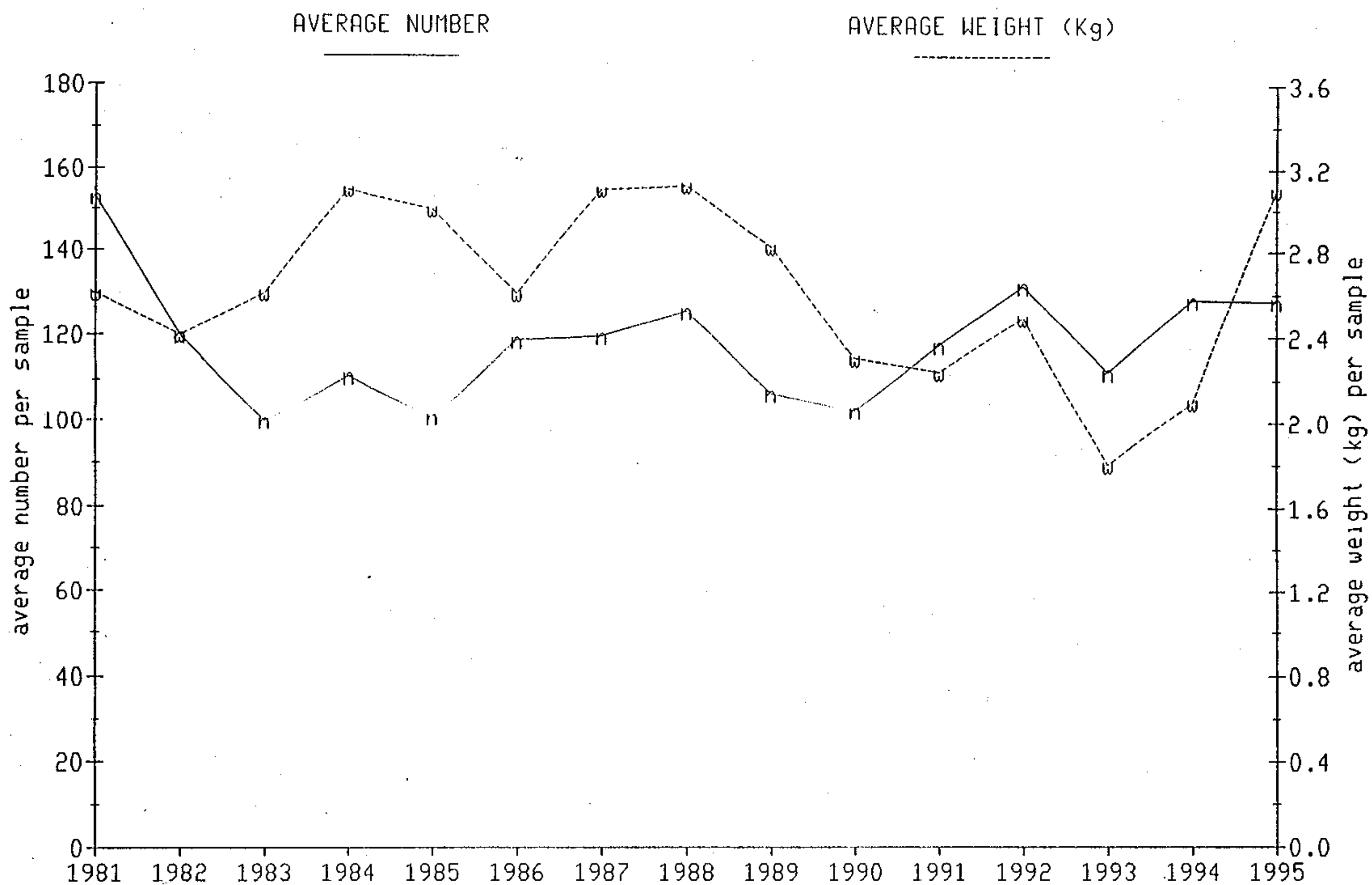


FIGURE 3.3-5 COMPOSITION OF LMB CATCH

(LAKE ANNA 1993-1995)

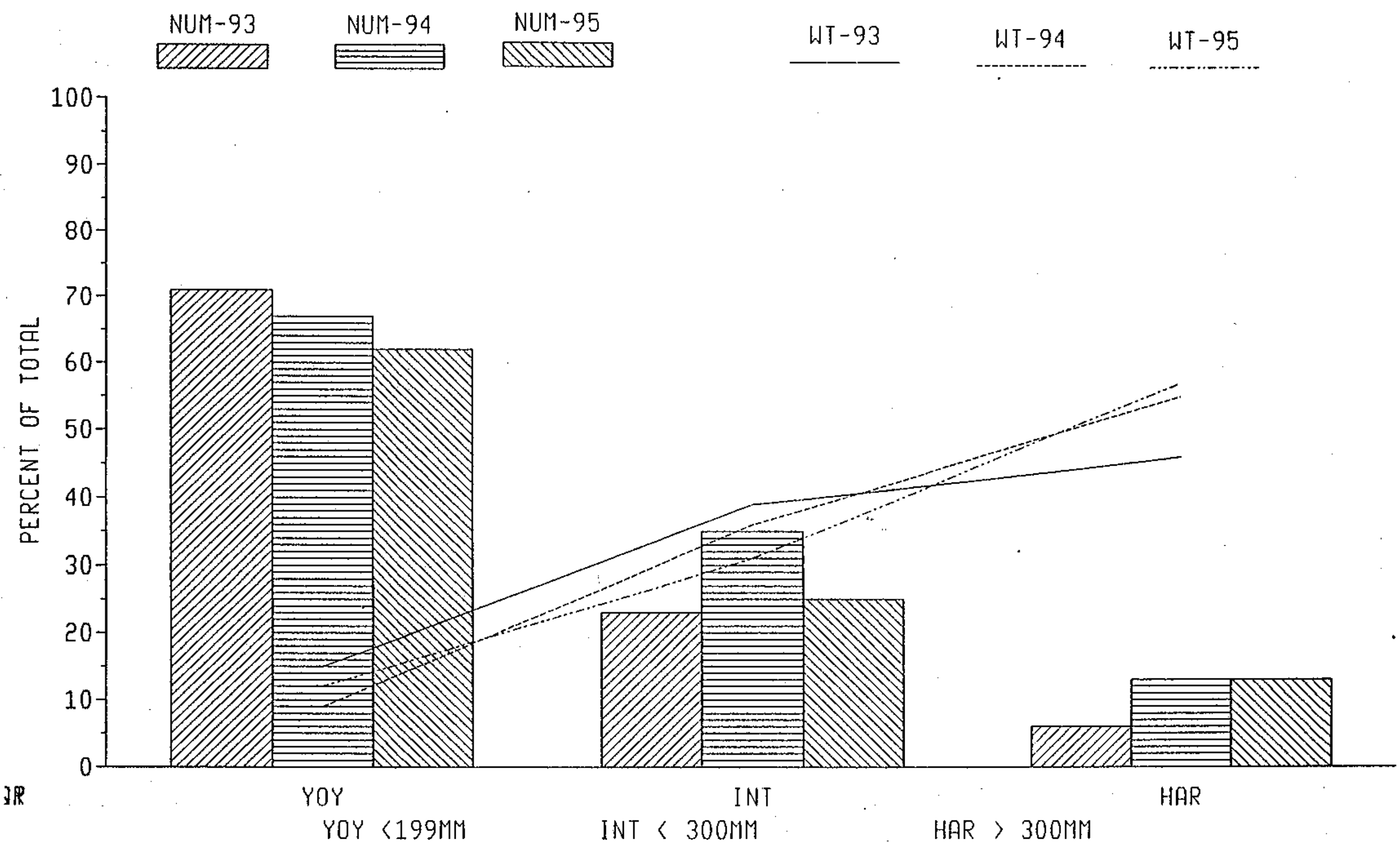


FIGURE 3.3-6 COMPOSITION OF BLUEGILL CATCH
(LAKE ANNA 1993-1995)

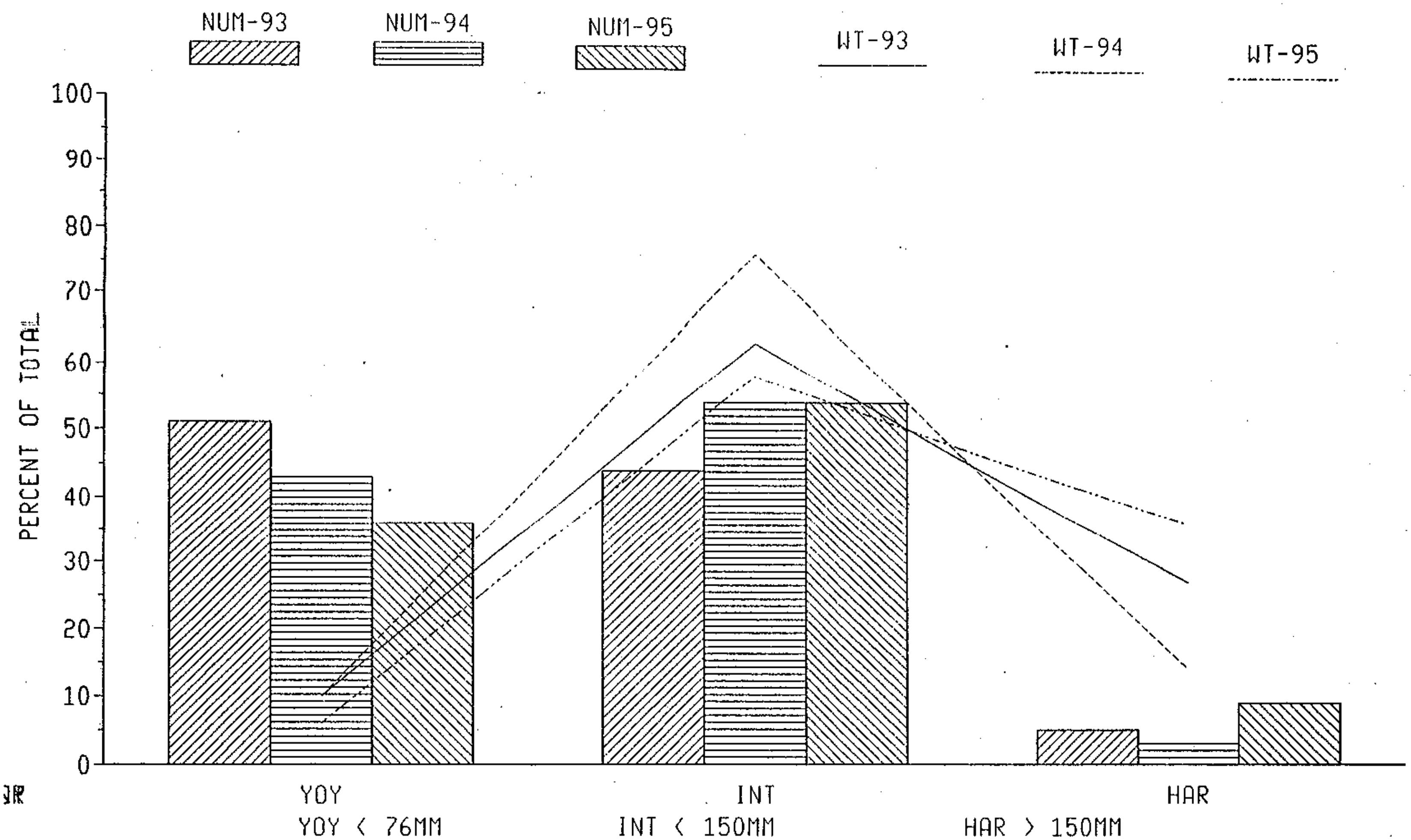


FIGURE 3.3-7 NORTH ANNA LARGEMOUTH BASS: COMPARISON OF LENGTH AND WEIGHT OVER TIME

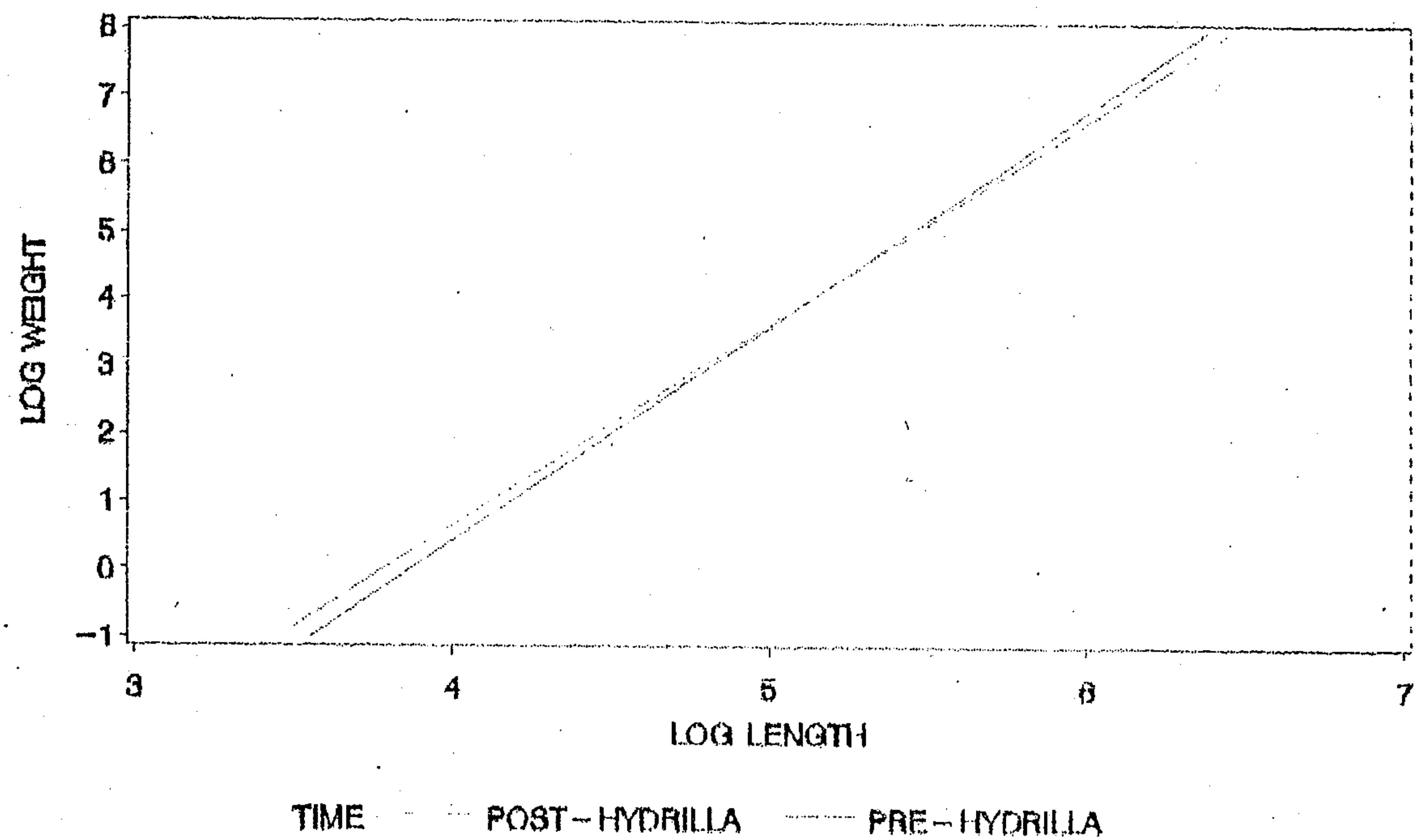


FIGURE 3.3-8 LENGTH FREQUENCY OF LARGEMOUTH BASS COLLECTED IN WHTF

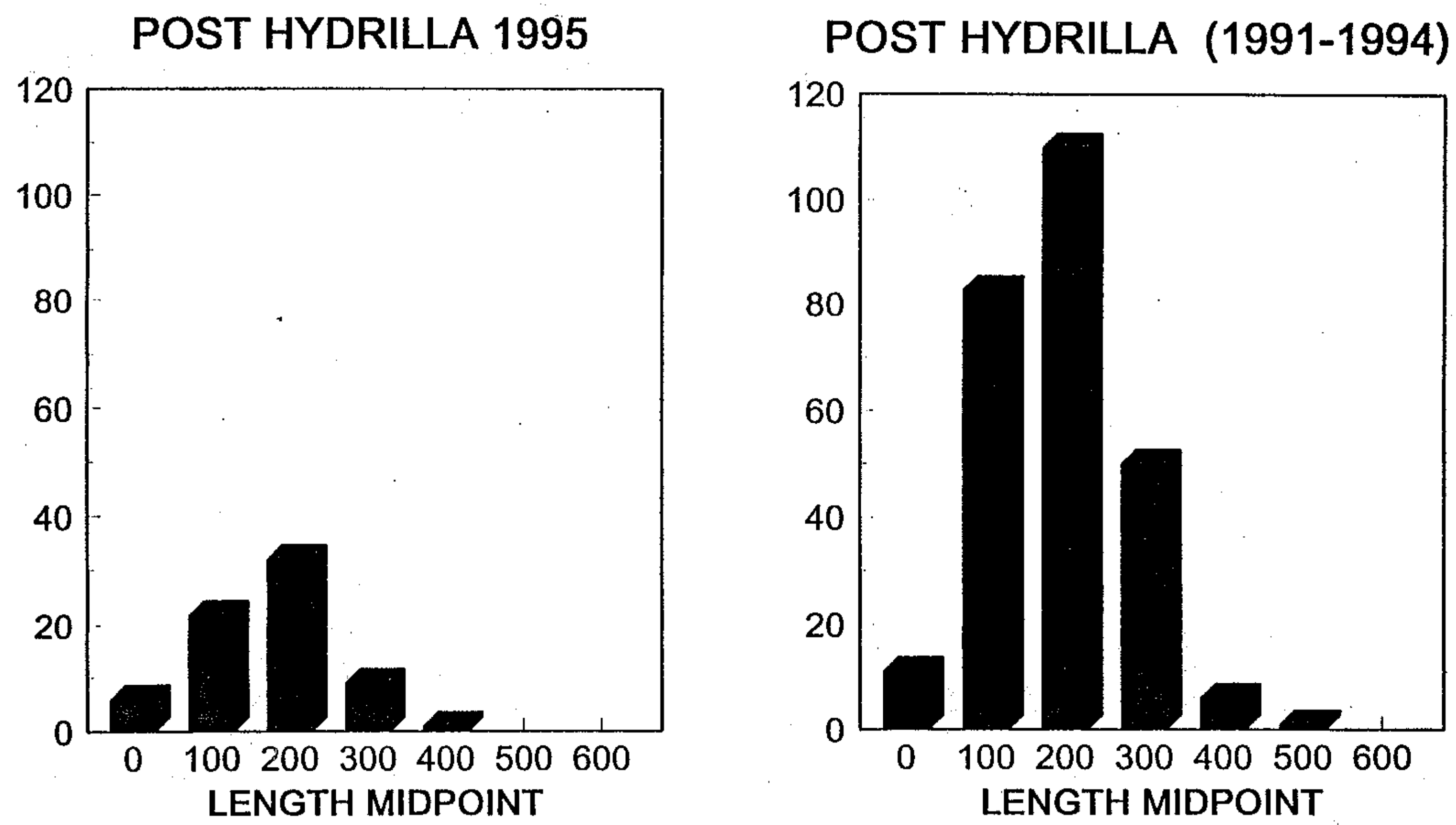


FIGURE 3.3-9 LENGTH FREQUENCY OF BLUEGILL COLLECTED IN WHTF

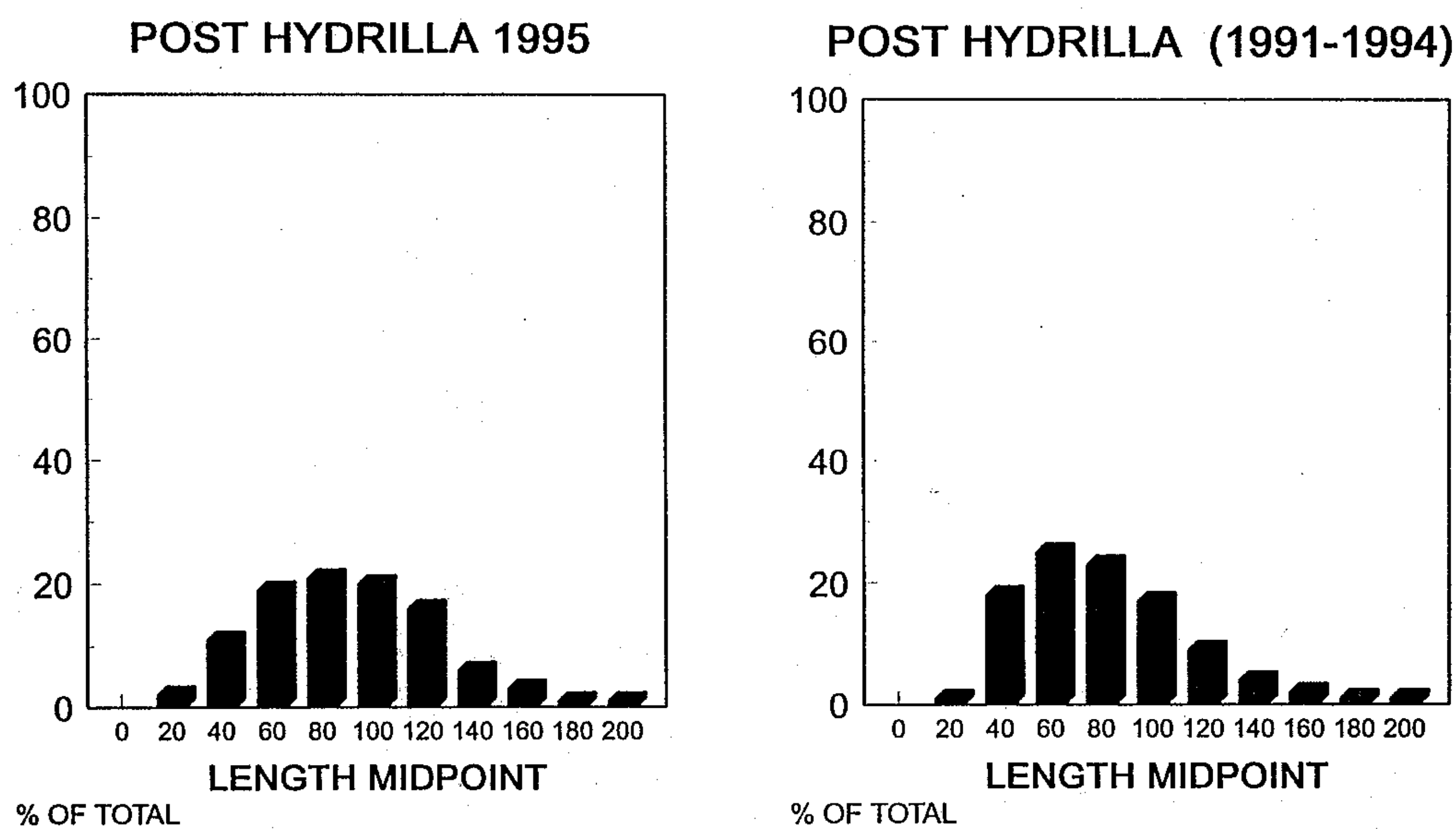


FIGURE 3.4-1 Lake Anna below VirginiaRoute 208 Bridge indicating hydrilla beds in 1995

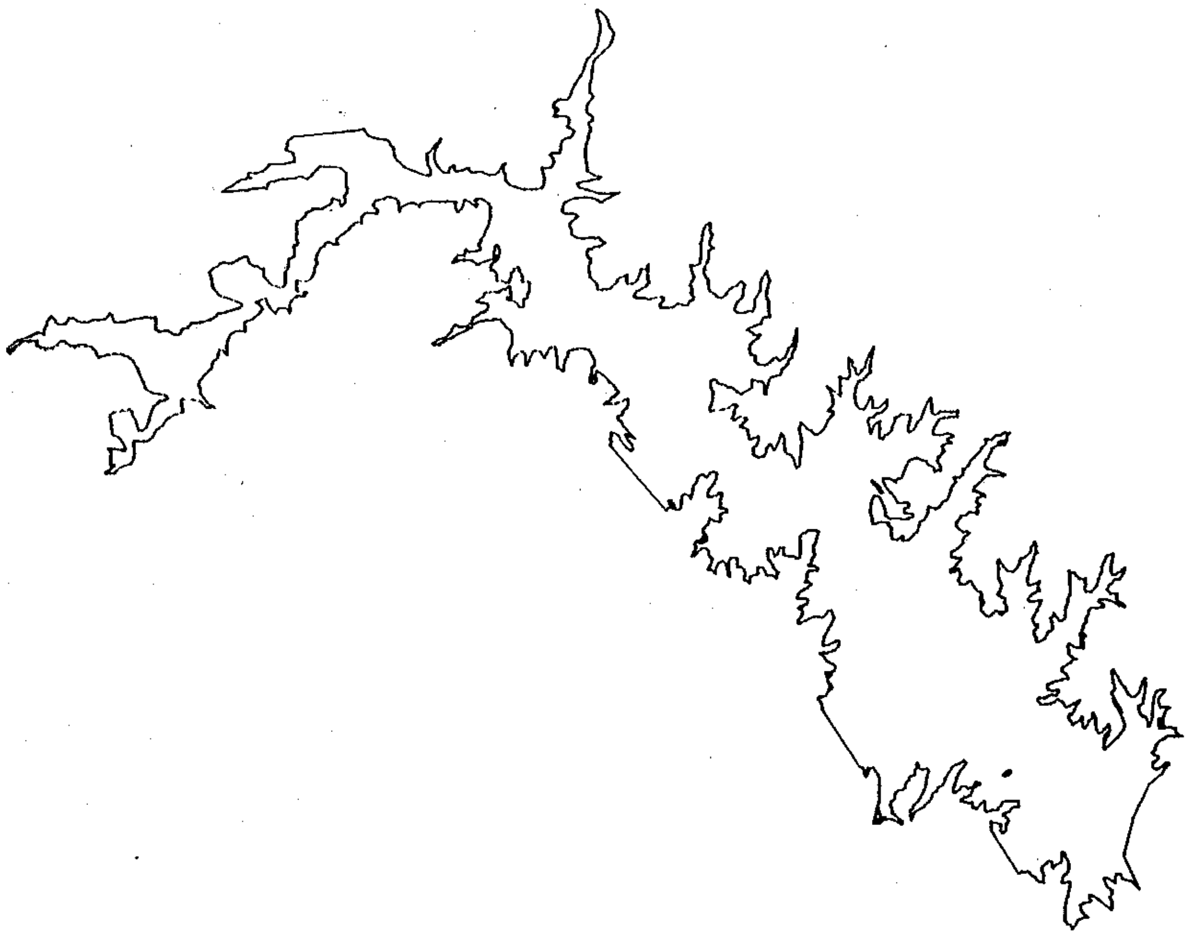


FIGURE 3.4-2 Lake Anna Lagoon 1 indicating hydrilla bed in 1995

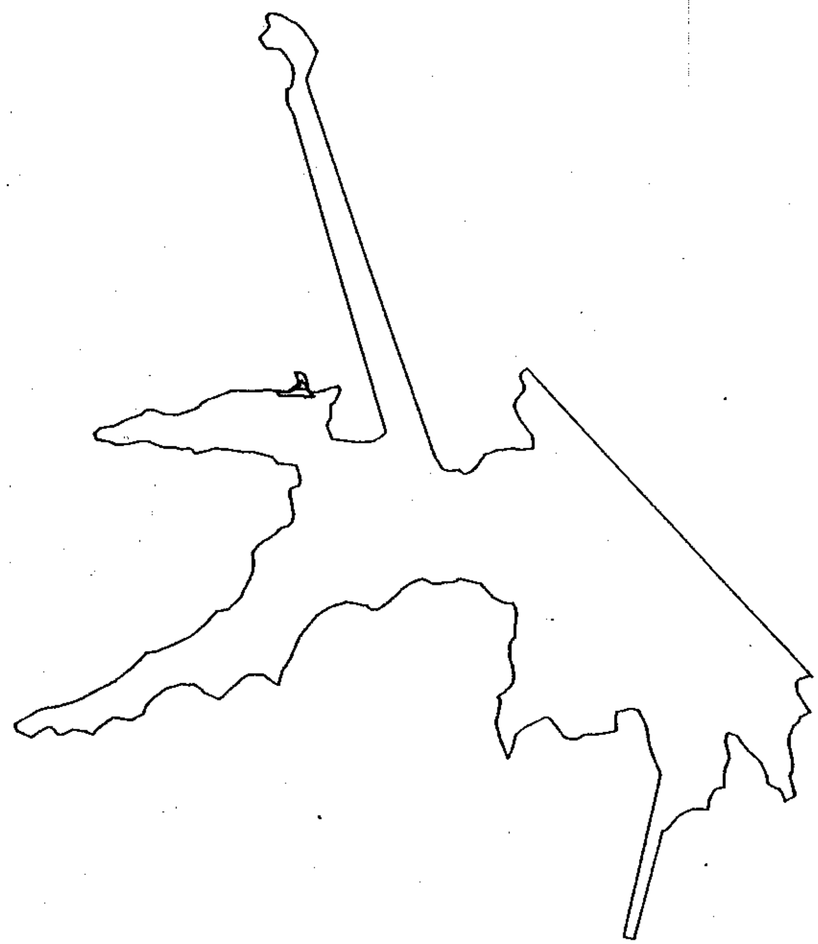


FIGURE 3.4-3 Lake Anna Lagoon 2 indicating hydrilla bed in 1995

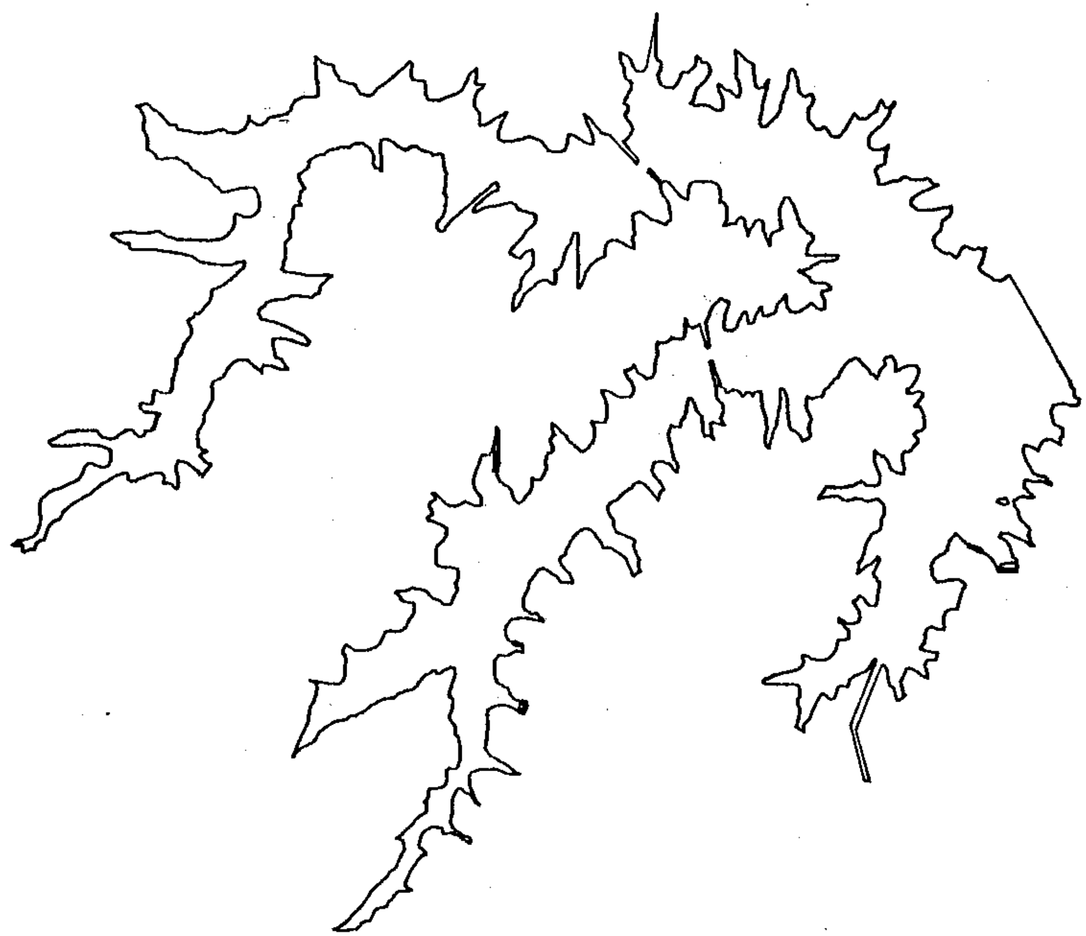
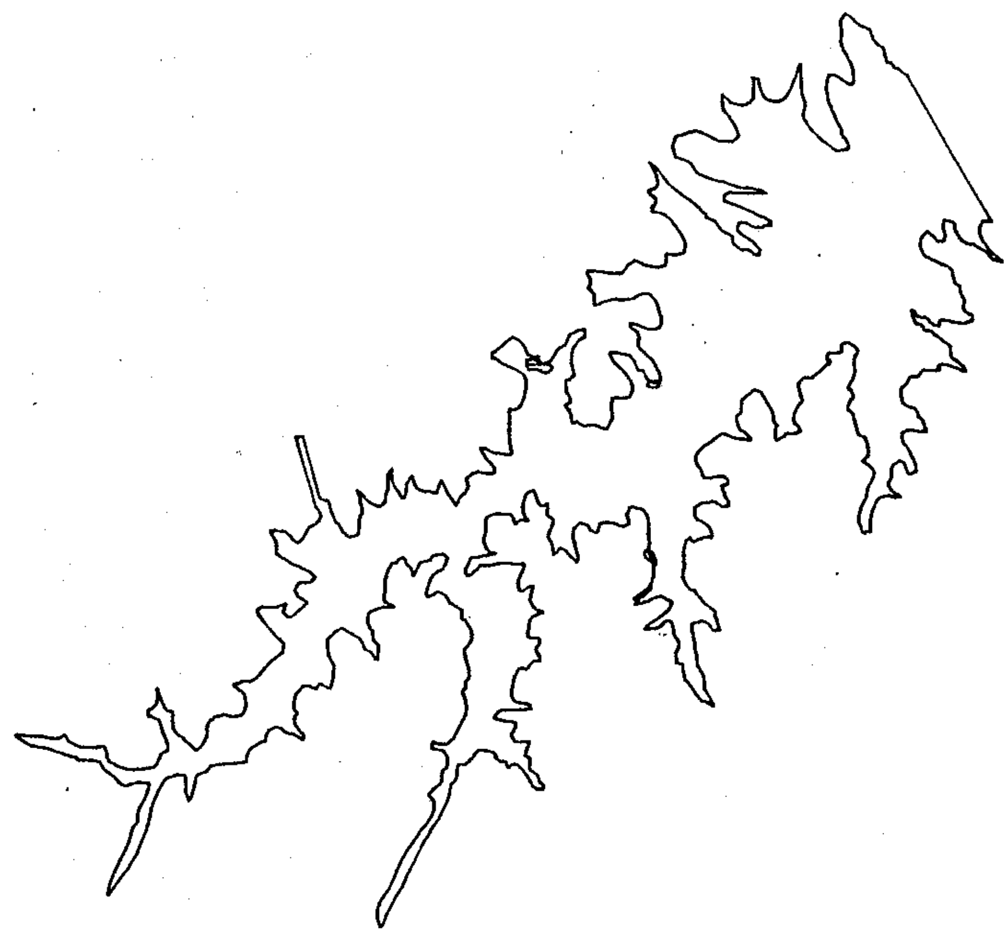


FIGURE 3.4-4 Lake Anna Lagoon 3 indicating hydrilla bed in 1995



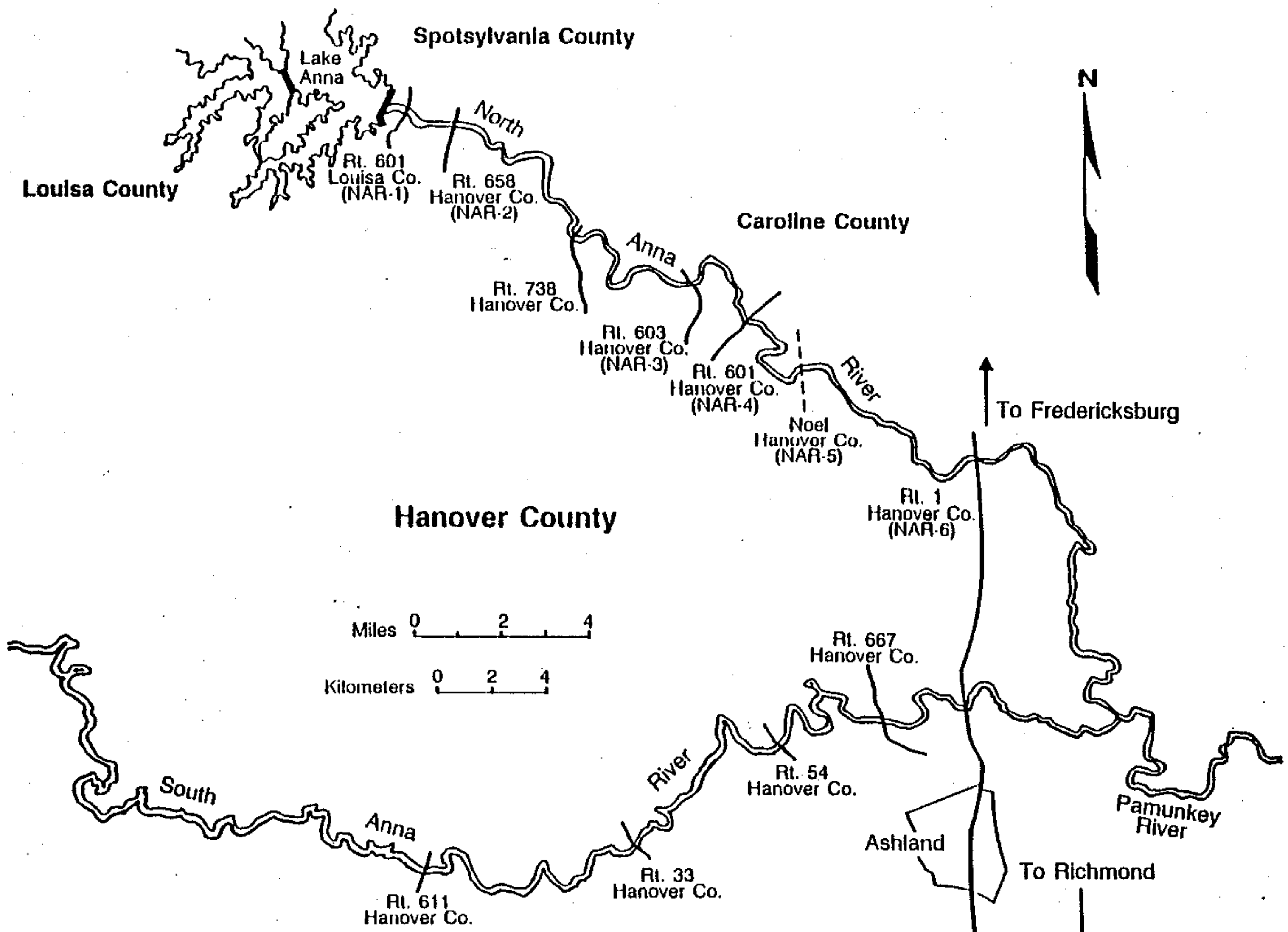


Figure 4.1-1. Location of North Anna River temperature recording, electrofishing, and snorkel survey stations.

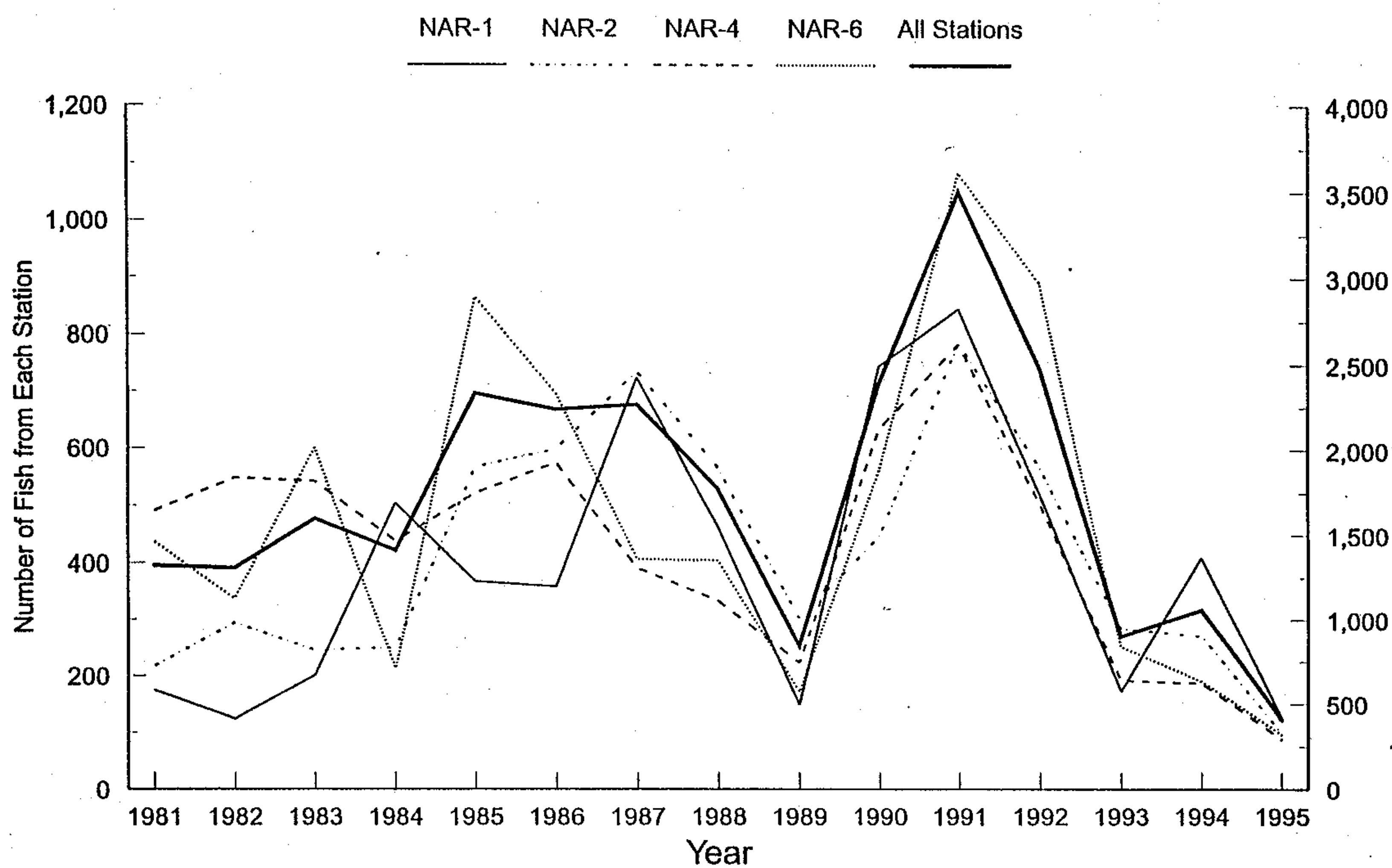


Figure 4.2-1. Number of fish annually collected from the North Anna River during electrofishing surveys, 1981-1995.

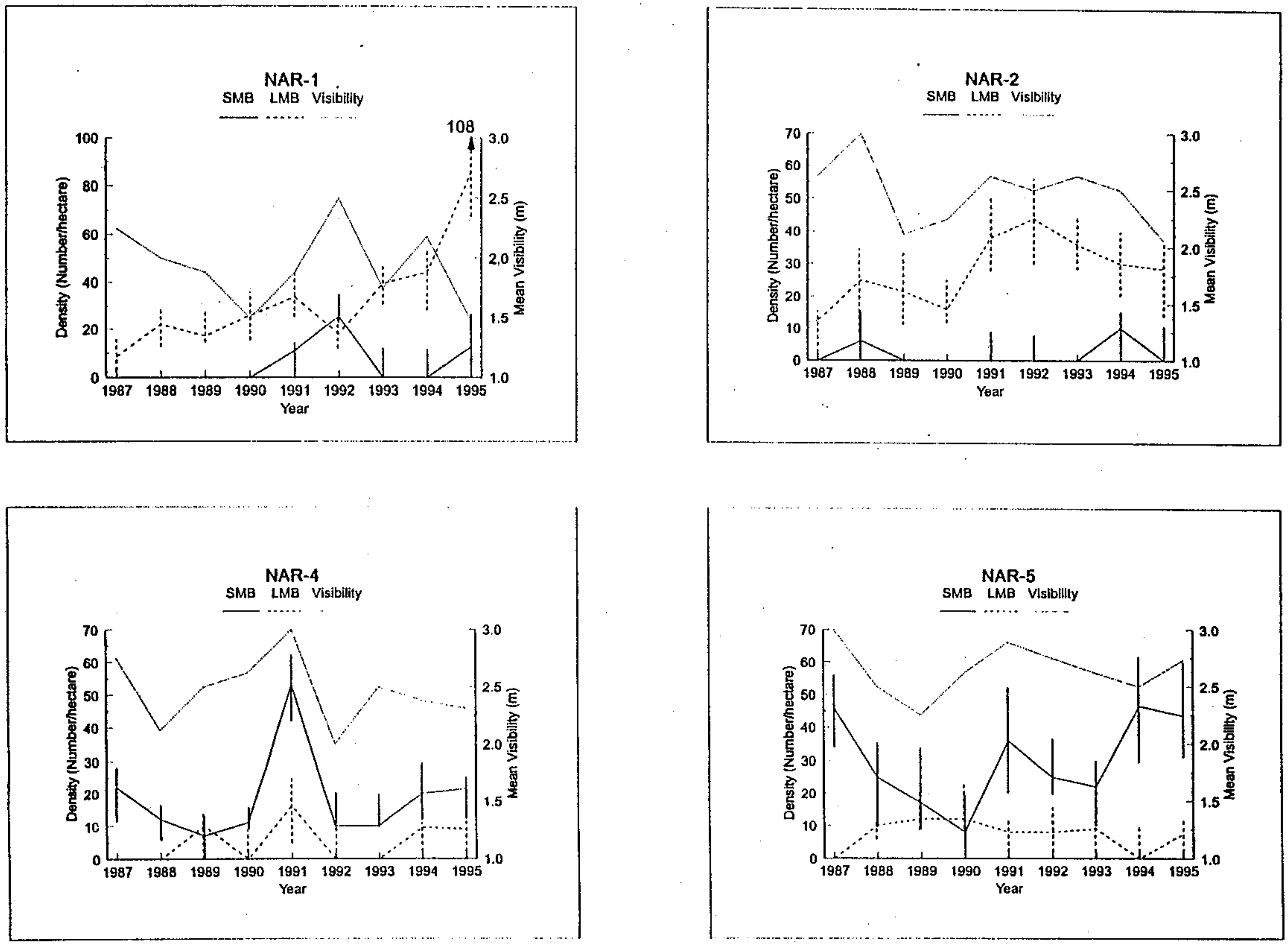


Figure 4.3-1. Median density estimates for smallmouth bass and largemouth bass larger than 120 mm TL, 95% confidence intervals, and median visibility estimates determined from North Anna River snorkel surveys, 1987-1995.

TABLE 2.0-1 Seasonal summary of North Anna Power Station operation (percent of total Station load) 1978-1995.

Year	Winter	Spring	Summer	Fall
1978	0	23	42	45
1979	43	31	44	0
1980	31	37	53	65
1981	46	80	67	82
1982	78	26	19	48
1983	53	58	96	84
1984	76	64	16	66
1985	87	96	82	62
1986	75	88	62	80
1987	92	45	23	47
1988	75	99	94	97
1989	47	26	87	65
1990	98	98	69	61
1991	63	89	84	92
1992	35	80	92	71
1993	49	83	79	82
1994	96	91	75	91
1995	87	64	98	97
Quarters at 75-100%	9	9	9	10

TABLE 3.1-1. SUMMARY OF NORTH ANNA FIXED RECORDER TEMPERATURE DATA DURING 1995. VALUES ARE MEANS OF DAILY HIGH, MEAN AND LOW TEMPERATURES (IN DEGREES CELSIUS). ALL INSTRUMENTS ARE LOCATED AT THE SURFACE EXCEPT FOR NALST10 WHICH IS AT MID-DEPTH. "*" INDICATES DATA MISSING DUE TO INSTRUMENT MALFUNCTION OR DAMAGE. HOURS OF DATA COLLECTED ARE SHOWN.

STATION NO.	6	5	4	2	1	3	10	7	8	9	
YEAR=95 MONTH=JANUARY											
TYPE	NAL719ST	NAL719NT	NAL208T	NALINT	NALTHIST	NALBRPTT	NALST10	NADISC1	NAWHTF2	NAWHTF3	NARIV601
HIGH	6.3	6.3	8.0	9.0	9.4	11.2	12.0	20.8	16.8	13.8	10.9
MEAN	6.1	6.1	7.7	8.8	9.2	10.9	11.8	20.4	16.2	13.5	10.5
LOW	5.9	5.9	7.4	8.6	9.0	10.6	11.5	20.1	15.6	13.2	10.2
HOURS	744	744	744	744	744	744	744	744	744	744	202
YEAR=95 MONTH=FEBRUARY											
TYPE	NAL719ST	NAL719NT	NAL208T	NALINT	NALTHIST	NALBRPTT	NALST10	NADISC1	NAWHTF2	NAWHTF3	NARIV601
HIGH	4.9	5.1	5.3	6.5	7.2	9.0	9.8	17.9	14.1	11.3	9.1
MEAN	4.6	4.6	4.8	6.1	6.8	8.6	9.5	17.6	13.5	11.0	8.7
LOW	4.3	4.2	4.5	5.8	6.5	8.3	9.2	17.3	12.9	10.6	8.2
HOURS	672	672	672	672	672	672	672	672	672	672	672
YEAR=95 MONTH=MARCH											
TYPE	NAL719ST	NAL719NT	NAL208T	NALINT	NALTHIST	NALBRPTT	NALST10	NADISC1	NAWHTF2	NAWHTF3	NARIV601
HIGH	11.4	11.0	11.3	11.6	12.0	13.0	13.0	20.7	17.5	15.8	13.1
MEAN	10.6	10.3	10.6	10.9	11.5	12.4	12.6	20.2	17.0	15.4	12.6
LOW	10.1	9.7	10.1	10.4	11.1	12.0	12.2	19.7	16.5	15.0	12.1
HOURS	744	744	744	744	744	744	744	744	744	744	744
YEAR=95 MONTH=APRIL											
TYPE	NAL719ST	NAL719NT	NAL208T	NALINT	NALTHIST	NALBRPTT	NALST10	NADISC1	NAWHTF2	NAWHTF3	NARIV601
HIGH	16.0	15.9	15.6	15.6	15.6	16.2	16.0	24.1	20.5	18.4	16.7
MEAN	15.2	15.1	15.0	15.0	15.1	15.6	15.6	23.8	19.8	18.0	15.8
LOW	14.6	14.4	14.5	14.5	14.7	15.2	15.3	23.5	19.2	17.6	15.1
HOURS	720	719	720	720	720	719	719	719	719	719	720
YEAR=95 MONTH=MAY											
TYPE	NAL719ST	NAL719NT	NAL208T	NALINT	NALTHIST	NALBRPTT	NALST10	NADISC1	NAWHTF2	NAWHTF3	NARIV601
HIGH	22.2	21.9	21.5	21.3	21.0	21.1	20.6	27.5	24.8	23.7	21.4
MEAN	21.4	21.1	20.8	20.6	20.5	20.5	20.0	27.1	24.3	23.1	20.6
LOW	20.7	20.4	20.2	20.0	20.0	20.0	19.3	26.7	23.8	22.7	19.9
HOURS	744	744	744	744	744	744	744	744	744	744	744

TABLE 3.1-1(CONT.). SUMMARY OF NORTH ANNA FIXED RECORDER TEMPERATURE DATA DURING 1995. VALUES ARE MEANS OF DAILY HIGH, MEAN AND LOW TEMPERATURES (IN DEGREES CELSIUS). ALL INSTRUMENTS ARE LOCATED AT THE SURFACE EXCEPT FOR NALST10 WHICH IS AT MID-DEPTH. A "*" INDICATES DATA MISSING DUE TO INSTRUMENT MALFUNCTI ON OR DAMAGE. HOURS OF DATA COLLECTED ARE SHOWN

STATION NO.	6	5	4	2	1	3	10	7	8	9	
YEAR=95 MONTH=JUNE											
TYPE	NAL719ST	NAL719NT	NAL208T	NALINT	NALTHIST	NALBRPTT	NALST10	NADISC1	NAWHTF2	NAWHTF3	NARIV601
HIGH	26.9	26.5	25.9	26.3	26.2	26.2	25.7	32.9	30.8	29.3	26.2
MEAN	26.1	25.7	25.2	25.6	25.6	25.7	25.2	32.5	30.2	28.7	25.5
LOW	25.4	24.9	24.6	25.0	25.1	25.2	24.6	32.2	29.6	28.3	24.8
HOURS	720	720	252	720	720	720	720	720	720	720	720
YEAR=95 MONTH=JULY											
TYPE	NAL719ST	NAL719NT	NAL208T	NALINT	NALTHIST	NALBRPTT	NALST10	NADISC1	NAWHTF2	NAWHTF3	NARIV601
HIGH	30.6	29.8	32.1	30.7	30.3	30.4	29.6	36.9	35.0	33.2	30.5
MEAN	29.8	28.9	31.2	29.7	29.5	29.6	29.1	36.6	34.2	32.6	29.5
LOW	29.1	28.2	30.7	28.9	28.9	29.0	28.6	36.3	33.6	32.1	28.8
HOURS	742	491	105	743	744	744	744	742	742	741	740
YEAR=95 MONTH=AUGUST											
TYPE	NAL719ST	NAL719NT	NAL208T	NALINT	NALTHIST	NALBRPTT	NALST10	NADISC1	NAWHTF2	NAWHTF3	NARIV601
HIGH	31.0	*	*	31.1	30.7	31.5	31.3	38.1	35.7	33.7	31.3
MEAN	30.3	*	*	30.4	30.2	30.9	31.0	37.8	34.9	33.2	30.5
LOW	29.8	*	*	29.9	29.8	30.6	30.7	37.5	34.3	32.9	29.8
HOURS	744	0.0	0.0	744	744	744	744	744	744	744	744
YEAR=95 MONTH=SEPTEMBER											
TYPE	NAL719ST	NAL719NT	NAL208T	NALINT	NALTHIST	NALBRPTT	NALST10	NADISC1	NAWHTF2	NAWHTF3	NARIV601
HIGH	26.1	*	*	27.0	26.9	28.1	28.4	34.3	31.7	29.7	27.8
MEAN	25.5	*	*	26.5	26.5	27.7	28.1	34.1	31.1	29.3	26.8
LOW	25.1	*	*	26.2	26.2	27.4	27.9	33.9	30.6	29.0	26.0
HOURS	720	0.0	0.0	720	720	720	720	720	720	720	720
YEAR=95 MONTH=OCTOBER											
TYPE	NAL719ST	NAL719NT	NAL208T	NALINT	NALTHIST	NALBRPTT	NALST10	NADISC1	NAWHTF2	NAWHTF3	NARIV601
HIGH	21.3	18.2	19.9	23.4	22.8	23.9	24.3	30.1	27.9	25.8	23.8
MEAN	20.8	17.8	19.5	23.0	22.4	23.6	24.0	29.9	27.1	25.4	23.0
LOW	20.3	17.5	19.2	22.6	22.1	23.3	23.7	29.7	26.3	25.2	22.3
HOURS	744	180	181	562	743	742	743	744	742	744	743

TABLE 3.1-1(CONT.). SUMMARY OF NORTH ANNA FIXED RECORDER TEMPERATURE DATA DURING 1995. VALUES ARE MEANS OF DAILY HIGH, MEAN AND LOW TEMPERATURES (IN DEGREES CELSIUS). ALL INSTRUMENTS ARE LOCATED AT THE SURFACE EXCEPT FOR NALST10 WHICH IS AT MID-DEPTH. A "*" INDICATES DATA MISSING DUE TO INSTRUMENT MALFUNCTI ON OR DAMAGE. HOURS OF DATA COLLECTED ARE SHOWN

STATION NO.	6	5	4	2	1	3	10	7	8	9	
YEAR=95 MONTH=NOVEMBER											
TYPE	NAL719ST	NAL719NT	NAL208T	NALINT	NALTHIST	NALBRPTT	NALST10	NADISC1	NAWHTF2	NAWHTF3	NARIV601
HIGH	11.7	11.8	13.9	*	15.0	20.3	17.1	23.3	20.3	17.8	16.4
MEAN	11.4	11.4	13.6	*	14.7	20.0	16.9	23.0	19.8	17.5	16.1
LOW	11.1	11.1	13.3	*	14.5	19.7	16.7	22.6	19.4	17.3	15.8
HOURS	720	720	720	0.0	720	178	720	720	720	720	720
YEAR=95 MONTH=DECEMBER											
TYPE	NAL719ST	NAL719NT	NAL208T	NALINT	NALTHIST	NALBRPTT	NALST10	NADISC1	NAWHTF2	NAWHTF3	NARIV601
HIGH	5.6	5.8	7.9	*	9.4	*	12.0	20.0	15.7	13.1	11.3
MEAN	5.4	5.6	7.5	*	9.1	*	11.8	19.7	15.2	12.8	11.0
LOW	5.1	5.3	7.3	*	8.9	*	11.6	19.3	14.8	12.6	10.8
HOURS	744	744	744	0.0	744	0.0	744	744	744	744	744

TABLE 3.1-2. NORTH ANNA PLUME SURVEY SHOWING TEMPERATURES (IN CELSIUS DEGREES) MEASURED AT ONE METER INTERVAL DEPTHS FOR SELECTED STATIONS IN LAKE ANNA.

		STATION													
DATE	DEPTH (M)	A	B	C	D	E	F	G	H	I	J	K	L	M	N
950213	0	7.7	8.5	7.9	7.7	7.3	6.3	6.2	5.7	5.5	3.2	3.4	3.0	2.9	3.4
	1	7.6	8.5	7.8	7.5	7.3	6.3	6.2	5.6	5.4	3.2	3.3	3.0	2.9	3.4
	2	7.6	8.5	7.0	7.2	7.3	6.2	6.1	5.6	5.4	3.2	3.3	3.0	2.9	3.4
	3	7.6	8.5	6.9	7.1	7.2	6.2	6.1	5.5	5.4	3.2	3.3	3.0	3.0	3.4
	4	7.5	8.4	6.9	7.1	7.1	6.2	6.0	5.5	5.4	3.2	3.3	3.0		3.4
	5	7.5	8.3	6.9	7.1	7.1	6.2	6.0	5.5	5.4	3.2	3.3	3.0		3.5
	6	7.5	8.3	6.9	7.0	6.9	6.2	6.0	5.5	5.4	3.2	3.3	3.1		3.5
	7	7.5	8.3	6.9	7.0	6.9	6.2	6.0	5.4	5.4	3.2	3.3	3.1		3.4
	8	7.5	8.3	6.9	7.0	6.8	6.2	5.9	5.4	5.4	3.2	3.3			
	9	7.4	8.3	6.9	7.0	6.7	6.2	5.9	5.4	5.4	3.2	3.3			
	10	7.4	8.3	6.9	6.9	6.7	6.2	5.9	5.4	5.4	3.2	3.3			
	11	7.3	8.3	6.9	6.9	6.7	6.2	5.9	5.3	5.4	3.2	3.3			
	12	6.9	8.3	6.8	6.9	6.7	6.2	5.9	5.3	5.4	3.2	3.4			
	13	6.8	8.3	6.8	6.8	6.6	6.2	5.9	5.2	5.3	3.2	3.4			
	14	6.8	8.3	6.8	6.7	6.5	6.2	5.9	5.2		3.4				
	15	6.8	8.3	6.8	6.6	6.5	6.2	5.9	5.2						
	16	6.8	8.2	6.7	6.6	6.5	6.2	5.9							
	17	6.7		6.7	6.6	6.4	6.2	5.9							
	18	6.7		6.7	6.6	6.3	6.2	5.9							
	19	6.7		6.6	6.6		6.2	5.8							
	20	6.6													
	21	6.5													

TABLE 3.1-2(CONT.). NORTH ANNA PLUME SURVEY SHOWING TEMPERATURES (IN CELSIUS DEGREES) MEASURED AT ONE METER INTERVAL DEPTHS FOR SELECTED STATIONS IN LAKE ANNA.

DATE	DEPTH (M)	STATION A	B	C	D	E	F	G	H	I	J	K	L	M	N
950509	0	18.8	18.5	18.6	18.6	18.6	18.6	18.3	18.1	18.0	18.1	18.2	18.3	18.6	18.3
	1	18.7	18.4	18.5	18.5	18.5	18.4	18.0	18.0	17.9	18.0	18.0	17.9	18.4	18.0
	2	18.6	18.3	18.4	18.4	18.4	18.3	17.8	17.8	17.7	17.7	17.8	17.4	18.1	17.7
	3	18.5	18.1	18.1	18.2	18.2	18.2	17.7	17.6	17.4	17.5	17.6	17.0	17.1	17.2
	4	18.4	17.8	17.9	18.1	18.1	18.0	17.6	17.4	17.2	17.3	16.9	16.8	16.2	16.1
	5	18.3	17.5	17.5	17.9	18.0	17.8	17.4	17.0	17.1	17.1	16.4	16.3	15.5	15.8
	6	18.1	17.2	17.1	17.3	17.4	17.4	17.3	16.6	16.9	16.7	16.0	15.9	15.1	15.8
	7	16.8	16.5	16.9	17.1	17.0	16.8	16.9	16.3	16.7	16.5	15.3	15.3	14.7	15.7
	8	16.4	16.1	16.8	16.9	16.8	16.6	16.7	15.9	16.1	16.2	15.2		14.7	
	9	15.9	14.7	16.4	16.8	16.6	16.2	16.5	15.0	15.0	15.1	14.9			
	10	15.1	14.3	15.9	16.1	16.3	16.1	16.0	14.6	14.6	14.6	14.7			
	11	13.5	13.8	15.3	14.5	16.0	14.0	15.1	14.4	14.2	14.2	14.4			
	12	13.3	13.4	13.8	13.6	14.4	13.8	13.8	14.3	14.0	14.0	14.3			
	13	13.2	13.3	13.4	13.5	13.7	13.7	13.7	13.8	13.9	13.9				
	14	13.0	13.3	13.2	13.3	13.4	13.7	13.6	13.8		13.7	14.2			
	15	12.9	13.3	13.1	13.2	13.1	13.6	13.6	13.8						
	16	12.8	13.3	13.0	13.1	13.0	13.6	13.6							
	17	12.8		13.0	13.1	13.0	13.6	13.6							
	18	12.7		13.0	12.9	12.9		13.6							
	19	12.7		12.9	12.9			13.6							
	20	12.7													
	21	12.7													

TABLE 3.1-2(CONT.). NORTH ANNA PLUME SURVEY SHOWING TEMPERATURES (IN CELSIUS DEGREES) MEASURED AT ONE METER INTERVAL DEPTHS FOR SELECTED STATIONS IN LAKE ANNA.

DATE	DEPTH (M)	A	B	C	D	E	F	G	H	I	J	K	L	M	N
		STATION													
950822	0	30.9	30.8	31.0	31.1	31.1	30.7	30.9	30.5	30.2	30.4	30.3	30.1	29.9	30.3
	1	30.9	30.8	30.9	30.9	31.0	30.7	30.8	30.5	30.2	30.2	30.2	30.0	29.7	30.2
	2	30.8	30.7	30.7	30.6	30.8	30.6	30.7	30.2	30.2	30.0	29.9	29.9	29.4	29.9
	3	30.7	30.7	30.5	30.4	30.4	30.5	30.5	29.9	30.1	30.0	29.8	29.7	29.3	29.6
	4	30.6	30.6	30.3	30.2	30.2	30.4	30.4	29.8	30.1	30.0	29.7	29.5	29.2	29.5
	5	30.6	30.4	30.2	30.1	30.2	30.4	30.1	29.7	29.9	29.9	29.6	29.4	29.1	29.4
	6	30.6	30.2	30.1	30.0	30.1	30.3	29.9	29.6	29.8	29.8	29.5	29.2	29.0	29.3
	7	30.4	29.7	30.0	30.0	30.0	30.2	29.8	29.5	29.5	29.6	29.3	29.1	28.8	29.2
	8	29.9	29.2	29.9	29.9	29.9	29.9	29.7	29.4	29.3	29.3	29.1		28.6	
	9	29.6	28.7	29.8	29.8	29.8	29.7	29.5	29.3	29.2	29.2	28.9			
	10	29.4	28.6	29.5	29.5	29.6	29.5	29.3	29.2	28.9	28.8	28.5			
	11	28.5	28.2	29.1	29.2	29.3	29.3	28.9	28.8	28.6	28.4	27.9			
	12	28.1	27.8	28.3	28.5	28.6	28.8	28.6	28.5	28.3	28.1	27.7			
	13	27.9	27.3	28.0	28.2	28.2	28.3	28.2	28.2	27.9	28.0				
	14	27.6	26.8	27.6	27.7	27.9	28.0	28.0	28.0		27.3				
	15	26.8	26.6	27.1	27.4	27.5	27.6	27.8	27.8						
	16	25.4	26.5	25.8	25.6	26.1	27.2	26.8							
	17	23.2		22.9	23.6	24.3	26.5	25.6							
	18	21.6		21.6	22.0	22.5	23.2	23.1							
	19	19.3		20.3	20.9		21.8	20.8							
	20	18.3					11.9								
	21	17.2													

TABLE 3.1-2(CONT.). NORTH ANNA PLUME SURVEY SHOWING TEMPERATURES (IN CELSIUS DEGREES) MEASURED AT ONE METER INTERVAL DEPTHS FOR SELECTED STATIONS IN LAKE ANNA.

		STATION													
DATE	DEPTH (M)	A	B	C	D	E	F	G	H	I	J	K	L	M	N
951113	0	17.0	17.6	17.2	17.2	16.6	16.3	16.5	15.8	16.0	15.8	14.6	14.4	12.4	12.6
	1	17.1	17.6	17.2	17.2	16.7	16.3	16.5	15.9	16.0	15.9	14.6	14.4	12.4	12.6
	2	17.1	17.7	17.2	17.2	16.7	16.4	16.5	15.9	16.1	15.9	14.7	14.4	12.4	12.6
	3	17.1	17.7	17.2	17.2	16.8	16.5	16.4	15.8	16.1	15.9	14.7	14.4	12.4	12.7
	4	17.0	17.7	17.3	17.2	16.7	16.5	16.4	15.8	16.1	15.9	14.7	14.4	12.3	12.7
	5	16.9	17.7	17.2	17.0	16.6	16.5	16.4	15.8	16.1	15.9	14.7	14.4	12.4	12.6
	6	16.8	17.7	17.1	16.9	16.6	16.5	16.4	15.8	16.0	15.9	14.7	14.3	12.4	12.6
	7	16.8	17.7	17.0	17.0	16.6	16.5	16.4	15.7	16.0	15.8	14.7	14.3	12.4	12.6
	8	16.8	17.7	17.0	17.0	16.5	16.5	16.4	15.6	16.0	15.8	14.7		12.4	
	9	16.9	17.8	16.9	17.0	16.5	16.5	16.3	15.6	16.0	15.7	14.7			
	10	17.1	17.8	16.9	17.0	16.4	16.5	16.3	15.5	15.9	15.6	14.6			
	11	17.0	17.8	16.8	16.9	16.4	16.5	16.3	15.3	15.7	15.5	14.6			
	12	17.0	17.8	16.7	17.0	16.4	16.5	16.3	15.2	15.6	15.3	14.5			
	13	16.9	17.8	16.7	16.9	16.4	16.5	16.2	15.0	15.5	15.3				
	14	16.8	17.7	16.7	16.9	16.3	16.4	16.2	14.8		15.3				
	15	16.8	17.6	16.6	16.9	16.4	16.4	16.2	14.7						
	16	16.7	17.6	16.6	16.9	16.4	16.3	16.2							
	17	16.7		16.6	16.9	16.3	16.2	16.2							
	18	16.8		16.7	16.9	16.3	16.2	16.2							
	19	16.8			16.9		16.2	16.2							
	20	16.9					16.2								
	21	17.0													

Table 3.2-1. Fishes collected in Lake Anna, (1981-1995)

FAMILY	SPECIES	LAGOON 1	LAGOON 3	DIKE 1	DIKE 3
Anguillidae	Anguilla rostrata			X	X
Clupeidae	Alosa aestivalis				
	Dorosoma cepedianum	X	X	X	X
	Dorosoma petenense	X			
Esocidae	Esox americanus		X		
	Esox niger	X	X		
Cyprinidae	Cyprinella analostana		X		X
	Cyprinus carpio	X	X		
	Nocomis leptocephalus				
	Notemigonus crysoleucas	X	X		X
	Notropis procne	X	X		
Catostomidae	Catostomus commersoni				
	Erimyzon oblongus	X	X		
Ictaluridae	Ameiurus catus				X
	Ameiurus natalis		X	X	X
	Ameiurus nebulosus	X	X	X	X
	Ictalurus punctatus	X	X	X	X
Aphredoderidae	Aphredoderus sayanus				
Cyprinodontidae	Fundulus diaphanus				
Poeciliidae	Gambusia affinis	X			
Percichthyidae	Morone americana	X	X		X
	Morone saxatilis				
Centrarchidae	Lepomis auritus	X	X	X	X
	Lepomis gibbosus	X	X	X	X
	Lepomis gulosus	X	X	X	X
	Lepomis macrochirus	X	X	X	X
	Lepomis microlophus	X	X	X	X
	Micropterus salmoides	X	X	X	X
	Pomoxis nigromaculatus	X	X	X	X
Percidae	Etheostoma olmstedi	X	X		X
	Perca flavescens	X	X		

TABLE 3.2-2 GILL NET SUMMARY 1995

GILL NET - LAKE

STATION:ALL STATIONS	FEBRUARY		MAY		AUGUST		NOVEMBER		TOTALS		% OF TOTAL	
SPECIES	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
D.cepedianum	8	2305	116	27902	99	19135	15	4541	238	53883	43	22
P.nigromaculatus	13	1913	1	573	28	2168	28	5804	70	10458	13	4
M.saxatilis	33	53246	3	4061	4	6147	28	23958	68	87412	12	36
I.punctatus	3	604	17	15472	21	10526	6	4662	47	31264	8	13
A.catus	11	6115	9	2374	5	2308	16	6407	41	17204	7	7
M.americana	10	137	9	574	18	961	1	9	38	1681	7	1
M.salmoides	3	2462	3	867	6	2891	3	2859	15	9079	3	4
S.vitreum	6	5757					5	6780	11	12537	2	5
I.microlophus	1	129	1	162	6	632	1	165	9	1088	2	0
C.carpio			3	9353	1	2979	3	6508	7	18840	1	8
D.petenense			2	23	4	36			6	59	1	0
I.nebulosus	1	301	1	311	1	327			3	939	1	0
N.hudsonius			1	13			1	13	2	26	0	0
P.flavescens							1	178	1	178	0	0
L.macrochris							1	47	1	47	0	0
A.natalis					1	156			1	156	0	0
E.niger					1	512			1	512	0	0
Total No.	89		100		195		109		559		100	
Total Wt.	72969		61685		48778		61931		245363		100	

GILL NET TOTALS - WHTF

STATION:ALL STATIONS	FEBRUARY		MAY		AUGUST		NOVEMBER		TOTALS		% OF TOTAL	
SPECIES	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
D.cepediamun	29	11344	24	9210	12	3794	11	4728	76	29076	30	26
I.punctatus	19	12507	21	14175	12	7709	10	4872	62	39263	25	35
M.americana	17	2652	7	429			12	377	36	3458	14	3
M.salmoides	1	376	13	4316	2	232	19	5981	35	10905	14	10
A.catus	13	3995					1	287	14	4282	6	4
L.microlophus			4	565	9	1303			13	1868	5	2
C.carpio	3	5232	2	9303			2	6014	7	20549	3	18
P.nigromaculatus	1	87					4	989	5	1076	2	1
M.saxatilis	2	2245							2	2245	1	2
D.petenense			1	10					1	10	0	0
Total No.	85		72		35		59		251		100	
Total Wt.	38438		38008		13038		23248		112732		100	

TABLE 3.2-3 NUMBER AND WEIGHT (g) OF FISHES BY STATION COLLECTED DURING GILL NETTING ON LAKE ANNA DURING 1995

STATION		FEBRUARY	MAY	AUGUST	OCTOBER	TOTAL	AVERAGE
LAGOON 1							
	NUMBER	72	37	5	49	163	40.75
	WEIGHT	29084	15369	2115	19673	66241	16560.25
LAGOON 3							
	NUMBER	13	35	30	10	88	22
	WEIGHT	9354	22639	10923	3575	46491	11622.75
LEVY CREEK							
	NUMBER	17	63	24	12	116	29
	WEIGHT	19554	18599	5441	6333	49927	12481.75
LOWER LAKE							
	NUMBER	31	12	44	31	118	29.5
	WEIGHT	24714	1031	17574	20811	64130	16032.5
NORTH ANNA ARM							
	NUMBER	32	49	98	36	215	53.75
	WEIGHT	5400	21802	19531	15168	61901	15475.25
THURMAN ISLAND							
	NUMBER	9	42	29	30	110	27.5
	WEIGHT	23300	20253	6232	19619	69404	17351
TOTALS							
	NUMBER	174	238	230	168	810	202.5
	WEIGHT	111406	99693	61816	85179	358094	89523.5

TABLE 3.3-1 ELECTROFISH SUMMARY 1995
ELECTROFISH - LAKE
STATION:ALL STATIONS

SPECIES	FEBRUARY NUMBER	FEBRUARY WEIGHT	MAY NUMBER	MAY WEIGHT	AUGUST NUMBER	AUGUST WEIGHT	NOVEMBER NUMBER	NOVEMBER WEIGHT	TOTALS NUMBER	TOTALS WEIGHT	% OF TOTAL NUMBER	% OF TOTAL WEIGHT
L.macrochirus	572	7577	312	3118	214	2725	997	16979	2095	30399	75	38
M.salmoides	74	2756	38	8695	17	2905	72	11175	201	25531	7	32
L.gulosus	32	773	40	1224	13	407	75	1260	160	3664	6	5
L.microlophus	65	1148	17	540	10	268	30	666	122	2622	4	3
L.auritus	14	313	36	691	12	215	41	1568	103	2787	4	3
P. nigromaculatus	5	162	10	595	5	527	8	1006	28	2290	1	3
D.petenense					18	112			18	112	1	0
P.flavescens					16	778			16	778	1	1
N.crysoleucas			12	404					12	404	0	1
A.natalis			3	53	1	59	2	116	6	228	0	0
I.nebulosus	1	104	4	861	1	51			6	1016	0	1
m.americana	1	35	2	219	2	56			5	310	0	0
D.cepedianum			1	213	3	444			4	657	0	1
C.analostana			2	6			1	1	3	7	0	0
A. aestivalis	2	41							2	41	0	0
C.carpio	1	4373			1	4357			2	8730	0	11
I.punctatus			1	8					1	8	0	0
E.niger			1	442					1	442	0	1
F.diaphanus			1	3					1	3	0	0
A catus							1	6	1	6	0	0
Total No.	767		480		313		1227		2787		100	
Total Wt.	17282		17072		12904		32777		80035		100	

ELECTROFISH TOTALS - WHTF
STATION:ALL STATIONS

SPECIES	FEBRUARY NUMBER	FEBRUARY WEIGHT	MAY NUMBER	MAY WEIGHT	AUGUST NUMBER	AUGUST WEIGHT	NOVEMBER NUMBER	NOVEMBER WEIGHT	TOTALS NUMBER	TOTALS WEIGHT	% OF TOTAL NUMBER	% OF TOTAL WEIGHT
L.macrochirus	443	4836	292	3274	237	2154	577	6192	1549	16456	84	50
L.gulosus	28	849	43	1336	6	112	26	469	103	2766	6	8
M.salmoides	33	3280	24	1679	10	945	13	1647	80	7551	4	23
L.microlophus	31	742	22	875	7	409	17	535	77	2561	4	8
L.auritus	2	115	9	216	1	8	4	17	16	356	1	1
I.punctatus	2	46	4	1289	1	630	1	414	8	2379	0	7
A.natalis	1	30			1	109	1	70	3	209	0	1
P.nigromaculatus							1	12	1	12	0	0
A. catus							1	9	1	9	0	0
I.nebulosus	1	103							1	103	0	0
G.affinis							1	1	1	1	0	0
D.cepedianum							1	361	1	361	0	1
									0	0	0	0
Total No.	541		394		263		643		1841		100	
Total Wt.	10001		8669		4367		9727		32764		100	

TABLE 3.3-2 NUMBER AND WEIGHT (g) OF FISHES BY STATION COLLECTED BY ELECTROFISHING ON LAKE ANNA DURING 1995

STATION	FEBRUAR	MAY	AUGUST	NOVEMBER	TOTAL	AVERAGE
LAGOON 1						
NUMBER	90	52	69	113	324	81
WEIGHT	1127	963	1987	2244	6321	1580.25
LAGOON 3						
NUMBER	30	63	39	65	197	49.25
WEIGHT	1070	1787	1379	942	5178	1294.5
DIKE 1-WHTF						
NUMBER	251	143	137	302	833	208.25
WEIGHT	3279	2949	771	3803	10802	2700.5
DIKE 3-WHTF						
NUMBER	170	136	18	163	487	121.75
WEIGHT	4525	2970	230	2738	10463	2615.75
DIKE 1-LAKE						
NUMBER	172	154	35	254	615	153.75
WEIGHT	1347	2233	1742	4687	10009	2502.25
DIKE 3-LAKE						
NUMBER	112	114	42	193	461	115.25
WEIGHT	1861	1928	1449	2427	7665	1916.25
LOWER LAKE						
NUMBER	172	46	93	143	454	113.5
WEIGHT	4882	1229	1708	1215	9034	2258.5
THURMAN ISLAN						
NUMBER	272	53	44	605	974	243.5
WEIGHT	3636	3169	1118	22296	30219	7554.75
NORTH ANNA AR						
NUMBER	39	113	99	32	283	70.75
WEIGHT	5556	8513	6888	2152	23109	5777.25
TOTAL NUMBER	1308	874	576	1870	4628	1157
TOTAL WEIGHT	27283	25741	17272	42504	112800	28200

TABLE 3.4-1 ESTIMATE OF HYDRILLA (Hydrilla verticillata) COLONIZATION OF LAKE ANNA AND WASTE HEAT TREATMENT FACILITY (WHTF). NORTH ANNA POWER STATION. 1995 SURVEY

	LAKE ANNA	WASTE HEAT TREATMENT FACILITY			WHTF TOTAL
		LAGOON 1	LAGOON 2	LAGOON 3	
TOTAL ACRES	9600	225	2206	969	3400
AVAILABLE ACRES OF HABITAT(1)	3885	110	1158	442	1710
ACRES OF HYDRILLA COLONIZATION	14	.5	4.6	5	10.1
PERCENT OF AVAILABLE HABITAT COLONIZED	.3 %	.4 %	.4 %	.1 %	.5 %

(1) ACRES OF 15 FEET OR LESS WATER DEPTH

Table 4.1-1. Mean, maximum, and minimum hourly water temperatures (C) recorded in the North Anna River, by month, during 1995. Sample size (n) equals the number of hourly observations recorded each month.

	NAR-1				NAR-3			
Month	Mean	Max	Min	n	Mean	Max	Min	n
January	10.5	10.9	10.2	202	7.3	7.8	6.8	202
February	8.7	9.1	8.2	672	6.6	7.2	5.8	672
March	12.6	13.1	12.1	744	11.8	12.5	11.0	744
April	15.8	16.7	15.1	720	15.5	16.5	14.4	720
May	20.6	21.4	19.9	744	19.7	20.5	18.8	744
June	25.5	26.2	24.8	720	24.3	25.0	23.4	720
July	29.5	30.5	28.8	740	27.7	28.7	26.8	739
August	30.5	31.3	29.8	744	27.7	28.5	26.7	744
September	26.8	27.8	26.0	720	22.0	22.8	21.1	720
October	23.0	23.8	22.3	743	18.6	19.7	17.4	744
November	16.1	16.4	15.8	720	13.5	14.2	12.8	720
December	11.0	11.3	10.8	744	8.6	9.1	8.0	744

Table 4.2-1. Number and biomass (g) of fishes collected during July and September 1995 electrofishing surveys of the North Anna River.

Family / Species	NAR-1		NAR-2		NAR-4		NAR-6		Total	
	Number	Mass	Number	Mass	Number	Mass	Number	Mass	Number	Mass
Petromyzontidae										
Lampetra appendix			2	9.6	1	5.6			3	15.2
Anguilladae										
Anguilla rostrata	20	963.7	3	45.6	4	89.6	2	60.2	29	1159.1
Cyprinidae										
Cyprinella analostana			10	4.8	8	10.1	7	21.8	25	36.7
Lythrurus ardens	24	38.9	9	10.6	6	12.0	23	21.3	62	82.8
Nocomis leptocephalus					5	200.3			5	200.3
Nocomis micropogon	2	51.6	1	39.2	13	587.8			16	678.6
Notropis amoenus	2	5.6	2	3.2					4	8.8
Notropis procne			21	17.3			1	0.5	22	17.8
Notropis rubellus	2	2.0	4	5.3	11	15.8	10	19.5	27	42.6
Semotilus corporalis					5	173.2	2	6.4	7	179.6
Catostomidae										
Hypentelium nigricans	6	458.8	3	75.4	1	58.4	4	87.4	14	680.0
Ictaluridae										
Amieurus natalis							1	33.2	1	33.2
Noturus gyrinus							1	2.6	1	2.6
Noturus insignis	9	62.9	7	39.5	14	106.4	14	76.3	44	285.1
Centrarchidae										
Lepomis auritus	34	831.2	21	180.9	14	268.1	20	489.2	89	1769.4
Lepomis macrochirus	7	172.8	1	36.9	1	41.4	5	220.6	14	471.7
Lepomis microlophus	2	5.0							2	5.0
Micropterus dolomieui			1	16.8					1	16.8
Micropterus salmoides	1	26.6							1	26.6
Percidae										
Etheostoma olmstedi	5	4.9	3	1.7	2	2.1	2	3.9	12	12.6
Etheostoma vitreum			2	0.5			4	4.8	6	5.3
Percina peltata	11	27.5	8	12.4	3	7.5			22	47.4
Total	125	2651.5	98	499.7	88	1578.3	96	1047.7	407	5777.2
Number of Species		13		16		14		14		22

Table 4.2-2. Fishes collected from the North Anna River during annual electrofishing surveys, 1981-1995.

Family	Species	NAR-1	NAR-2	NAR-4	NAR-6
Petromyzontidae	*Lampetra appendix*		X	X	X
	Petromyzon marinus	X	X	X	X
Anguillidae	*Anguilla rostrata*	X	X	X	X
Esocidae	*Esox americanus*				X
	Esox niger	X	X	X	X
Cyprinidae	*Cyprinella analostana*	X	X	X	X
	Hybognathus regius			X	X
	Luxilus cornutus			X	
	Lythrurus ardens	X	X	X	X
	Nocomis leptocephalus	X	X	X	X
	Nocomis micropogon	X	X	X	X
	Notemigonus crysoleucas	X	X	X	X
	Notropis amoenus	X	X	X	X
	Notropis hudsonius				X
	Notropis procne	X	X	X	X
	Notropis rubellus	X	X	X	X
	Phoxinus oreas			X	
	Rhinichthys atratulus				X
	Semotilus corporalis	X	X	X	X
Catostomidae	*Catostomus commersoni*		X		X
	Erimyzon oblongus	X	X	X	
	Hypentelium nigricans	X	X	X	X
	Moxostoma macrolepidotum		X	X	X
Ictaluridae	*Ameiurus natalis*	X	X	X	X
	Ameriurus nebulosus	X	X		X
	Ictalurus punctatus				X
	Noturus gyrinus				X
	Noturus insignis	X	X	X	X
Aphredoderidae	*Aphrododerus sayanus*			X	X
Percichthyidae	*Morone americana*	X			
Centrarchidae	*Acantharchus pomotis*	X			
	Centrarchus macropterus				X
	Lepomis auritus	X	X	X	X
	Lepomis gibbosus	X	X	X	X
	Lepomis gulosus				X
	Lepomis macrochirus	X	X	X	X
	Lepomis microlophus	X	X		X
	Micropterus dolomieu	X	X	X	X
	Micropterus salmoides	X	X	X	X
	Pomoxis nigromaculatus	X	X	X	X
Percidae	*Etheostoma olmstedi*	X	X	X	X
	Etheostoma vitreum	X	X	X	X
	Perca flavescens	X			X
	Percina notograma		X	X	X
	Percina peltata	X	X	X	X
Soleidae	*Trinectes maculatus*				X

Table 4.2-3. Ranked abundance of species comprising greater than 80 percent of the pooled annual North Anna River electrofishing catch from all stations, 1981-1994. A species rank of 1 indicates it was the most abundant fish collected.

Species	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Notropis procne	2	1	1	1	1	1	1	1	1	4	2	3	1	2	7
Cyprinella analostana	1	2	2	3	2	2	5	2	3	2	1	1	3	6	6
Lepomis auritus	3	3	3	2	3	4	2	3	2	1	4	2	2	1	1
Notropis rubellus	--	5	8	8	10	3	3	4	4	3	3	5	4	3	5
Noturus insignis	8	--	--	--	6	5	4	6	7	8	5	6	5	4	3
Percina peltata	--	--	7	4	5	6	--	5	--	5	6	--	8	5	8
Anguilla rostrata	4	4	4	6	9	--	6	--	6	7	--	7	6	7	4
Lythrurus ardens	--	--	--	--	7	7	7	--	--	--	7	4	7	--	2
Nocomis micropogon	6	--	5	--	--	8	--	--	--	--	8	8	--	--	9
Nocomis leptocephalus	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Semotilus corporalis	--	--	9	--	4	9	--	--	--	--	--	--	--	--	--
Notropis amoenus	7	6	--	7	--	--	--	--	5	--	--	--	--	--	--
Hypentelium nigricans	--	--	--	--	8	--	--	--	--	--	--	--	--	--	--
Notemigonus crysoleucas	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--
Pomoxis nigromaculatus	--	--	6	--	--	--	--	--	--	--	--	--	--	--	--
Total number of species collected	26	27	29	31	31	29	32	30	18	25	25	29	25	25	22
Number of species accounting for >80%	8	6	9	7	10	9	7	6	7	7	8	8	8	7	9
Percent of electrofishing catch	83	82	81	83	83	83	80	82	80	80	84	83	83	85	82

* -- Indicates species was not among those comprising greater than 80% of the electrofishing catch

Table 4.3-1. Number of smallmouth bass and largemouth bass observed during North Anna River snorkel surveys conducted in 1995. Sample size (n) equals the number of times each count was performed in 1995.

				Smallmouth bass[1]			Largemouth bass[2]		
Station	Bank	Count	n	SMBYOY	SMB<11	SMB>11	LMBYOY	LMB<12	LMB>12
NAR-1	North	1	6	2	3	0	6	5	16
		2	6	1	4	1	13	7	17
		3	6	3	0	0	14	14	9
	South	1	6	4	2	1	10	1	10
		2	6	5	1	0	13	2	10
		3	6	2	7	0	20	2	10
NAR-2	North	1	6	2	1	2	1	1	2
		2	6	1	0	2	1	1	1
		3	6	0	0	2	2	4	2
	South	1	6	5	1	0	2	6	1
		2	6	5	2	2	1	7	4
		3	6	3	2	2	5	8	5
NAR-4	North	1	6	3	4	2	0	3	4
		2	6	0	2	4	0	1	5
		3	6	1	4	3	1	1	2
	South	1	6	1	1	2	0	0	0
		2	6	2	2	3	0	0	0
		3	6	0	6	2	0	0	1
NAR-5	North	1	6	4	17	9	0	3	1
		2	6	2	12	13	0	0	3
		3	6	0	17	13	0	0	5
	South	1	6	1	3	0	1	0	0
		2	6	1	4	2	0	3	0
		3	6	2	4	2	0	5	0

[1] SMBYOY were less than or equal to 120 mm, SMB<11 were 121-279 mm, SMB>11 were larger than or equal to 280 mm TL.

[2] LMBYOY were less than or equal to 120 mm, LMB<11 were 121-304 mm, LMB>11 were larger than or equal to 305 mm TL.

Table 4.3-2. Cover use by smallmouth bass and largemouth bass in the North Anna River observed during the first of three counts made during snorkel surveys conducted in 1995.

	Cover Type				
NAR-1	Ledge	Boulder	Wood	Vegetation	Open*
SMBYOY**	0	1	4	1	0
SMB<11	0	1	3	1	0
SMB>11	0	0	1	0	0
LMBYOY	0	0	10	4	2
LMB<12	0	0	3	2	1
LMB>12	0	0	17	5	4

NAR-2	Ledge	Boulder	Wood	Vegetation	Open
SMBYOY	0	0	3	2	2
SMB<11	0	0	1	0	1
SMB>11	0	0	0	0	0
LMBYOY	0	0	2	2	0
LMB<12	0	0	4	1	2
LMB>12	0	0	2	0	0

	Cover Type				
NAR-4	Ledge	Boulder	Wood	Vegetation	Open
SMBYOY	2	0	2	0	0
SMB<11	0	1	0	0	4
SMB>11	0	2	1	0	1
LMBYOY	0	0	0	0	0
LMB<12	0	1	1	1	0
LMB>12	0	1	3	0	0

NAR-5	Ledge	Boulder	Wood	Vegetation	Open
SMBYOY	2	1	1	0	1
SMB<11	10	3	2	0	5
SMB>11	6	1	1	0	1
LMBYOY	0	0	0	0	0
LMB<12	1	0	2	0	0
LMB>12	0	0	1	0	0

* Fish observed in open water were farther than 0.5 m from any cover type.

** See Table 4.3-1 for size category definitions.

Table 4.3-3: Cover use by smallmouth bass and largemouth bass in the North Anna River observed during the first of three counts made during snorkel surveys conducted in 1995. Data for observations at all stations are pooled.

All Stations	Cover Type: Ledge	Boulder	Wood	Vegetation	Open*
SMBYOY**	4	2	10	3	3
SMB<11	10	5	6	1	10
SMB>11	6	3	3	0	2
LMBYOY	0	0	12	6	2
LMB<12	1	1	10	4	3
LMB>12	0	1	23	5	4

* Fish observed in open water were farther than 0.5 m from any cover type.

** See Table 4.3-1 for size category definitions.

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